

ANNALS OF SURGERY

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No 1

SEPTIC OSTEOMYELITIS OF THE BONES OF THE SKULL AND FACE'

A PLEA FOR CONSERVATIVE TREATMENT†

BY VILRAY PAPIN BLAIR, M D

AND

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FROM THE SURGICAL DEPARTMENT OF THE WASHINGTON UNIVERSITY MEDICAL SCHOOL

IN THIS paper it is proposed to consider only inflammation or death of bone due to infection with a pus-producing organism, but three somewhat distinct clinical entities will be included

- 1 The condition commonly called "ulcerated tooth"
- 2 Frank otitis and necrosis of the dentigerous bones
- 3 The spreading otitis and necrosis that may accompany or follow pus infection of the para-nasal or para-aural sinuses

Our reasons for including these in one group are

- 1 They are each essentially a bone infection, and though showing certain individualizing characteristics, the pathology is basically the same, the reaction differing rather in degree than kind, and we believe the treatment of each is essentially the same
- 2 Further, while the lines that demarcate the typical cases in each group can be sharply drawn, there occur apparently borderline cases that are not so easily catalogued, and the close anatomical relation of the parts affected facilitates this grouping

General Conservatism in Treatment of Pus-infected Bones—There is an Italian proverb which says, "He who goes slowly goes safely, he who goes safely goes surely"

The above can be taken as a safe guiding text in the treatment of simple osteomyelitis of at least the jawbones. The general plan of good surgical treatment of simple purulent osteomyelitis was firmly established many years ago, and, except as influenced by the presence of the teeth, its treatment when affecting the skull and jaws differs little from that of any other bone. Due partly to the superior resistance of the face and mouth tissues to most infections, and partly to the readiness with which spontaneous drainage is estab-

* Presented before the American Surgical Association, May 25 1926

† Of the matter herein contained, the "ulcerated tooth" was made the subject of an editorial presented previously in *Surgery, Gynecology and Obstetrics*. The case reports referring to osteomyelitis of the jaws were reported recently in *Surgical Clinics of North America*. The section relating to osteomyelitis of para-nasal sinus origin is based upon part of the data that is being gathered for a more formal presentation that is proposed to be made at a future date before the American Laryngological Association

lished around the teeth, in the jaw the disease has not the inherent fatal tendency that may characterize it elsewhere. On the other hand, the deformities that result, most commonly from ill-advised surgery, can be little short of ghastly. In certain spreading infections of calvarium this is not true. Resulting deformities are not marked, but disease is frequently fatal.

The accepted treatment of osteomyelitis in general, as handed down to the senior collaborator some thirty odd years ago, consisted in, first, the early establishment of drainage of the focus with the least possible operative trauma, second, waiting until the violence of the infection had subsided, the dead bone had spontaneously separated and sufficient new bone had been formed to maintain continuity before attempting any radical operation, third, at the proper time to remove all fragments of dead bone with limited damage to granulations lining their beds, and, where practicable, to remove all edges



FIG. 1—Case III

of live bone that overhang bed so that soft tissue can drop into and fill these defects. The latter can often be facilitated by fashioning appropriate and well-nourished flaps of skin and subcutaneous tissue, muscle may be included.

When the above program is faithfully and intelligently carried out the disease will seldom prove fatal or progressive, and successful sequestrectomy followed by permanent healing will usually be accomplished by one operation. When dealing with cavities in cancellous bone near joints the propriety of the latter part of the procedure may be questioned by some surgeons who are accustomed to filling such defects with Mostig's bonewax, gauze, or some other substance, but there are comparatively few instances where a live flap cannot be advantageously substituted for these foreign fillers.

Many advantageous refinements of technic have been more recently worked out. Especially desirable are those that strive to raise the resistance of the tissues or to protect the granulation lined cavities from secondary infection, or to sterilize them by non-corrosive lotions, but any radical departure from the basic principles just cited is apt to be followed by disaster or embarrassment in one form or another. This older plan of conservative treatment has in late years been subjected to very forceful attacks, first by the operating dentists and exodontists, later by the rhinologists. The following will be an attempted recapitulation of the facts as we have observed them.

OSTEOMYELITIS OF THE SKULL AND FACE

Portals of Entry—If we are to consider prophylaxis against spreading septic infections within the jawbones, we must go into the etiology at least as far as portals of entry

In the upper jaw the infection may apparently be by way of the nasal mucosa or antrum (See Case Reports I and II) In either jaw it can unquestionably be blood carried from a distance, as is common in osteomyelitis in other bones, but where infected teeth are present, it may be difficult to draw absolute conclusions

Commonly in children the necrosis apparently follows the extraction of a tooth, but in at least some of these the bone infection may have caused the symptoms for which the tooth was drawn When the symptoms are first noted immediately after the treatment of a quiescent non-vital tooth, this rather suggests a pre-existing periapical infection which may have been present for years When such an infection involves a tooth with intact walls, it must be considered as being of blood-borne origin In one child the necrosis followed an extraction during the acute stage of a fulminating infection, and we have had such a history in a few adult cases, but it has been our observation that trouble following extractions under such conditions is more apt to result in diffuse infection of the soft parts and occasionally the death of the patient rather than an extensive necrosis of the bone

While it is not safe to reach a *post hoc ergo propter hoc* conclusion in every, or even the majority of cases it is nevertheless, all things considered, a safe clinical bet that prevention of decay and of injury to the teeth will prevent possibly quite a large percentage of these bone infections There may occur a low-grade bone infection that forms little or more or less pain, and a variable amount of swelling It is apt to attack different parts of the same jaw or both jaws simultaneously or consecutively, throwing

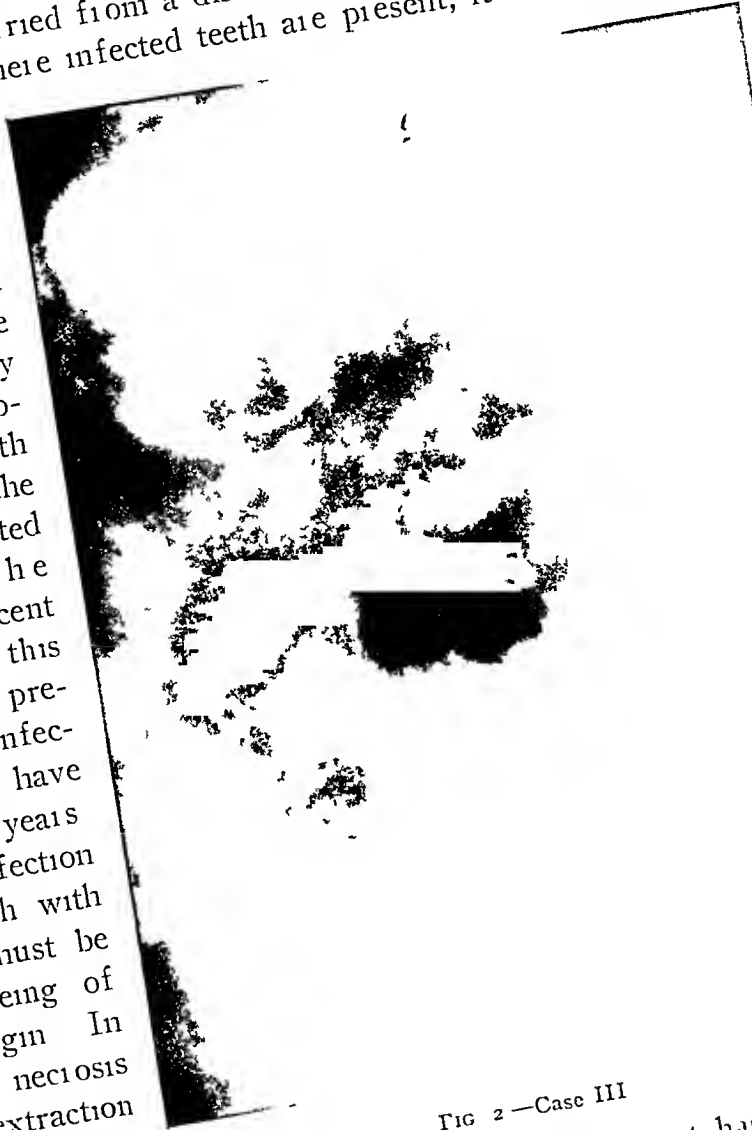


FIG 2—Case III

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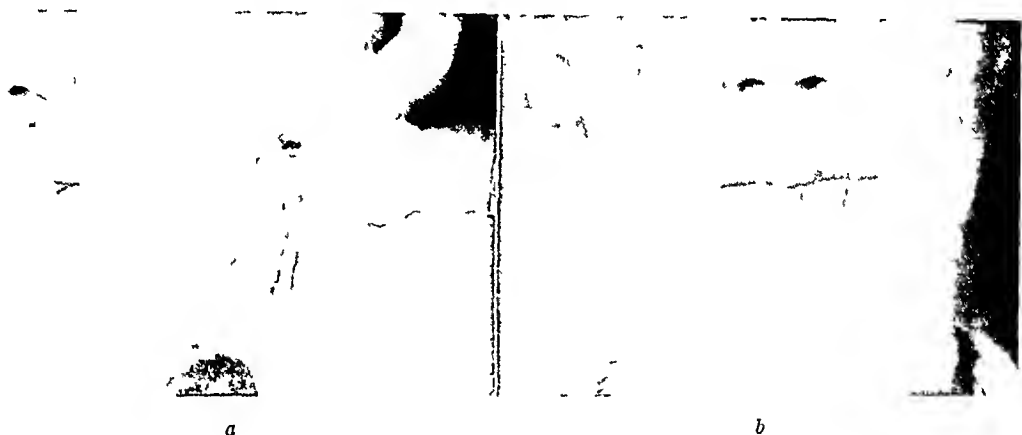


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There may occur a low-grade bone infection that forms little pus, more or less pain, and a variable amount of swelling It is apt to attack different parts of the same jaw or both jaws simultaneously or consecutively, throwing

off a sliver of bone here or loosening a tooth there, going on for a long time without coming to any definite conclusion or without showing any very definite head for surgical attack. The patient meanwhile may show various signs of intoxication.

In the earlier literature the belief that this type of necrosis was dependent on syphilis is quite common, but such an etiological factor now appears to be rather rare. The former belief was, in the past, quite firmly held by the senior writer of this paper. We find but few of the Wassermann reports of these cases to be positive, and it may be that the apparently good results from

anti-syphilitic therapy were due either to some antiseptic quality in the medication or to the delay entailed which gave further time for the development of specific antibodies.

In the bones of the calvarium the para-nasal sinuses are most commonly the portals of entry.

The "Ulcerated Tooth"—The above term commonly designates an acute exacerbation of a previously quiescent peri-apical infection, this naturally and by common consent will call for the ministrations of the dental sur-



FIG 3 —Case IV

geon. The attack may terminate or be terminated in one of several ways. After two days of suffering an abscess may perforate the bone, causing the typical "gum boil" or less commonly it may burrow out alongside of the root of the tooth. The dentist may get drainage through a root canal, or an attempt may be made to abort the process by extracting the tooth. The latter treatment has the virtue of precluding future attacks and may be followed by quick recovery, by a more or less protracted or stormy convalescence, or occasionally by death from general sepsis.

It was an old teaching in dentistry that these teeth should not be pulled during the period of acute swelling, and there is usually sound clinical observation back of these older teachings. With more modern and antiseptic technic, the general trend is to substitute active intervention for cultured conservatism and above all with the advent of the "exodontic" specialist, this

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older teaching lost precedence. The attempt to establish free drainage and at the same time remove the supposed focus is apt to appeal more strongly to the new dentist. This procedure has been compared to the removal of an acutely diseased appendix, but the simile is inapt because the appendix is the focus of the infection, while the tooth is at this time but an inert plug. In their results the two procedures do not parallel and the observer standing on the side line, who takes occasion to sort over the wreckage, is apt to conclude that the average results do not justify the extra risk inherent to early extraction. In a certain small percentage of cases the reaction is accompanied by an increase of symptoms, or is followed by abscess formation, or extensive bone necrosis. In addition to this some young or apparently robust people will die from general sepsis following extraction of an "ulcerated tooth" in the acute stage. On the other hand, death following the conservative plan is extremely rare, and except among young children, cervical abscess or extensive bone necrosis is uncommon, where the tooth and the bone are spared the trauma of instrumentation in the acute stage of the infection.

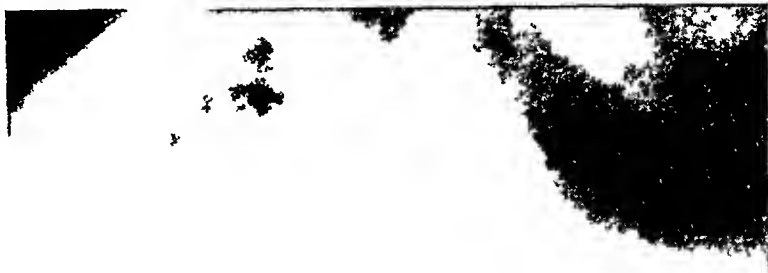


FIG. 4—Case V

This may seem difficult to explain, but a

study of the history of a typical case will at least furnish food for thought.

The "ulcerated tooth" is a culmination of an infection that has been present for an indefinite time, possibly years, without giving more than mild or unidentified symptoms. Often the root canals of the damaged tooth had long ago been sealed by the dentist, and it is usually difficult to assign any logical cause for the explosion. About the simplest explanation is the assumption that a disturbance of the balance between virulence and resistance has occurred which permits the hitherto imprisoned bacteria to successfully attack the confining barriers. Such a period of low resistance may be the reason why the trauma of an extraction may not be well tolerated at this particular time. This type of acute osteomyelitis should hold more than an academic interest for both the physician and the surgeon, either of whom must occasionally help a patient to choose between the man who offers immediate and permanent relief from a jumping toothache by a painless extraction

under gas, and the old-fashioned dentist who prescribes quinine, phenacetin, the mustard foot bath, the fig poultice, and who may attempt to establish drainage by the somewhat painful process of opening a root canal. The former may be the more brilliant procedure, but we can still give the conservative man our moral support with the assurance that his plan is the safer. Besides, the physician can always add sufficient morphine at least to ease the time of travail, and possibly he may shorten it by an incision and a stripping up of the periosteum at the likely site of perforation.

At a later period when the balance between virulence and resistance has been reestablished in the patient's favor, extraction of the tooth is not only safe, but is better surgery than the most effective dental restoration.

This taboo against immediate extraction applies only to the period of acute local symptoms evidenced chiefly by swelling of the neighboring soft tissues,



FIG 5—Case VI

and by the pain and tenderness that are characteristic of early osteomyelitis, not to the subacute stage in which discomfort, low fever, adenitis, malaise, rheumatism or joint infections, etc., may evidence chronic infection. If, however, an extraction under these latter conditions is followed by a severe local flare-up, then there may be good reason to go slow on repeating the insult.

Necrosis of the Jawbones—Simple osteomyelitis of the upper jaw resembles the same affection in other cancellous bones, in that it is of more rare occurrence and the necrotic areas are apt to be less extensive.

In either jaw the need for early artificial drainage of the focus is seldom urgent, though confined or pocketing collections of pus should be liberated by internal or external incision when detected. It is maintained by many of the dental profession that the application of external heat in the early stages fosters the formation of an external fistula. We have done the thing that has given the patient the greatest comfort, whether it has been the use of heat or cold.

The very objectionable odor that is given off from some older cases of

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jaw necrosis we have found to be controlled by one or two thorough irrigations of all fistulae with a quantity of 1 per cent solution of formalin ($2\frac{1}{2}$ per cent solution of the 40 per cent preparation of formalin) in water. The stinging pain of the injection does not last long, but can be modified by a previous irrigation with 1 per cent novocain.

It is difficult to set an exact time, but in the ordinary straightforward acute osteomyelitis of the jaw the dead bone will usually have separated itself in ninety days, and by this time a strong involucrum will have formed that will permit the removal of the sequestrum without changing the normal contour of the jaw. It has been our observation that instrumental manipulation of the bone, of at least the lower jaw, before the infection has lost its virulence, is very apt to be followed by further extension of the necrosis. In certain cases in which the periosteum has been stripped off or other



FIG 6—Case VI

attempts have been made to dislodge a piece of dead bone before it has become loose, we have found different segments in the same jaw that have been dead for different periods of time, so that one piece may be loose, "worm-eaten," and encased in a strong involucrum, while a neighboring piece may have but recently died and not yet detached, or if detached, surrounded by so little new bone formation that after its removal the jaw may collapse at this segment or the bone may fail to regenerate. (See Case III.)

In some cases of extensive necrosis it may be very good surgery to divide the radical operation into several steps, thoroughly cleaning out one area at a time. We have found that the surest way of cutting the necessary number of radical operations to the minimum is to give a full three months between the original infection, or any subsequent instrumentation, before attempting to remove the dead bone, and then, if it is not found to be "worm-eaten" and surrounded by a definite bed of granulations, to wait another three months before making a subsequent attempt.

For other reasons it may be desirable to wait very much longer than

three months before disturbing dead bone that is in close relation to developing teeth. Up to a very few years ago it was our practice to remove not only all loose "worm-eaten" fragments of bone, but all teeth and tooth buds that were definitely within the necrosed area on the theory that they must be dead and could only act as harbingers of infection. It was Dr. Virgil Loeb of this city who first called our attention to a case of which had a very striking series of X-rays. The first showed certain partially developed teeth to be very definitely surrounded by dead bone. Doctor Loeb had not done a radical operation, but had waited for the dead fragments to be thrown off spontaneously, with the result that the tooth buds continued to develop, and the

slightly deformed teeth had become fixed in the newly developed jawbone as demonstrated by a radiograph. Since then we have verified this result on several of our own patients, and it is now our custom in treating necrosis of the body of the jaw in a child to furnish drainage as indicated, watch closely for kidney damage, and, if the general condition permits, to do no radical operation on the alveolar portion, but wait for the fragments to be thrown off spontaneously. Fortunately, in children in the tooth-bearing areas



FIG 7a—Case VII

the dead bone is not apt to become deeply sequestered, as may happen in the ramus, but this does not hold true with adults (See Case IV). The preservation of the tooth buds is of tremendous advantage. In areas where they are completely lost, the new bone is apt to be short to the extent of very serious deformity (See Cases V and VI). If one first or second molar is preserved, it may save excessive retraction of the regenerated jaw, but preservation of the third molar bud will not do this (See Cases VII and VIII and V and VI).

Much more disastrous than the removal of tooth buds is the complete lack

‡ Cryer quotes Percy, of Paris, in 1791, as having observed that teeth in the necrosed area of bone finally recovered their original solidity and were firmly implanted in the thickened gum. Necrosis following extraction was known as far back as Heister's time (1710), and he warned against extractions in inflammatory affections of the jaws.

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of regeneration that may follow the too early removal of the dead bone or the attempt to control infection by resecting the original live bone (See Cases VI and IX) We know of one case in which the entire lower jaw is lacking from repeated attempts of this kind, and there never has come under our notice a single instance of failure of regeneration of the mandible following a simple osteomyelitis that had not been subjected to early energetic bone surgery (See Case IX)

Plan of Removal of Sequestra—In the lower jaw the incision is made along the alveolar process, or (as was necessary in Case IV), an incision can be made on the skin surface along the lower border of the mandible and part way up the posterior border of the ramus from one side to the other For necrosis of the ramus in adults, for locating dislodged spicules in the sigmoid notch, the posterior part of the incision just described is most appropriate

After the sequestrum has been exposed, slip a curette under the various fragments and ease them out, the cutting edge turned toward the dead bone and not toward the involucrum This plan is usually sufficient, even for a totally necrosed ramus and condyle When the sequestrum is buried in hard bone, it



FIG 7b—Case VII

may be necessary to chisel away one wall of the involucrum before the above can be carried out Where the pockets are multiple they must be dealt with individually, but all may be cleared out at one operation A curette makes a most efficient persuader, and it should be used as a tractor, an elevator, or as a tool to carve away overhanging involucrum, but as a bone scraper only when hunting for hidden fistulæ that might lead to other sequestra Bone scraping as a habit is a pernicious practice, and is to be deplored even when necessary The search for small deeply buried spicules may be greatly facilitated by a preliminary injection of the fistula with methylene-blue solution

In every case every piece of dead bone must be removed or so treated that it can be discharged spontaneously, otherwise, the wound will not heal permanently. It is for the lack of such treatment that many cases remain unhealed for a period of years that otherwise might have been cured in a few months.

In the upper jaw the sequestra are apt to become buried in scar. In seeking to remove these, it is a better plan to dissect out the scar than to try to find the individual pieces of bone. This is sometimes true in regard to

fragments in the neck that have worked down from the lower jaw (See Case X)

In all the preceding the emphasis has been on time-consuming conservatism, but when conditions become right for a radical operation, one should act boldly and efficiently. The necrosed alveolar process will be thrown off spontaneously or with very little help, but pieces of dead bone in the body or ramus will become encased by the living bone unless surgically removed and can remain indefinitely as a focus of infection (See Cases XIII, XIV, and XV). If, after the sequestrum has been re-



FIG 7c—Case VII

moved, the pocket in the involucrum is very deep, surrounded possibly by overhanging walls, such a cavity may take years to scar over, and, therefore, should not be left in this condition.

Conservatism the Most General Choice—The literature still shows the old division between those who advocate early conservatism versus those who promise to abort the disease by the earliest possible radical surgery. The position of the latter, who are still in the minority, is supported by neither new arguments nor any adequate number of convincing case reports.

CASE REPORTS ¶

Cases considered in this paper do not include those primarily due to open injury to the bone, this rules out all open fractures.

¶ The "follow-up" of these cases has been made possible only by the cooperation and work of the Social Service Department.

OSTEOMYELITIS OF THE SKULL AND FACE

The case reports are taken from cases treated since 1916 at Baines Hospital, St Louis Children's Hospital and St Louis Mullanphy Hospital, because since that time the plan of recording histories has been more uniform

CASE I—Girl, two and a half years Infection of maxilla, occurring most likely through antrum during course of diphtheria, treated expectantly, followed by recovery

During course of diphtheria swelling of right side of face occurred with, later, a discharge of pus Removal of loose pieces of bone from outer surface of maxilla five, six, and seven months later, with entire recovery

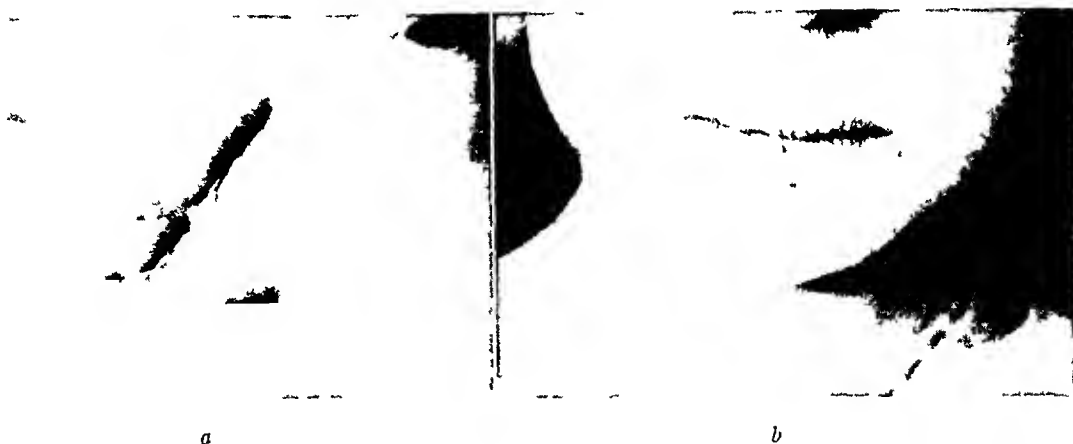


FIG 8—Case VII

CASE II—Baby, six and a half months Infection of maxilla and orbit probably of antral origin Early bony extension, bony incision for drainage—death from pneumonia

Well-nourished baby developed severe general symptoms of an infection and a swelling of the upper gum and hard palate, which later extended to face and orbit Seven days later, in an effort (probably ill-advised) to obtain drainage, entrance was



FIG 9—Case IX

made through the palate into orbit and antrum, removing several infected tooth buds Nine days later the orbit was again entered and more pus obtained, but the child died of pneumonia This is the only case in the whole series of jaw cases that terminated fatally, and we feel that the child's chances of recovery were not helped by the early bone-cutting operation

Marx, in 1920, called attention to the ocular lesions consecutive to osteomyelitis of the upper jaw in infants

Nord, in 1924, again called attention to it, and stated that the correct diagnosis was often missed He gave as treatment a conservative outlet for pus and waiting for spontaneous separation of the sequestrum, with which plan we are in full accord

CASE III—Boy, five years. Necrosis of the mandible which probably antedated tooth extraction, bone-cutting operation followed by a further spread of the necrosis, too early removal of necrosed ramus, followed by failure of regeneration of the ramus, persistent fistula due to retained dead, partially developed crown.

The boy had two molar teeth on left side extracted on account of swelling of the face, and a piece of loose bone was removed from the gum in the clinic three days after the extraction. This suggests that the necrosis had antedated the tooth extraction by some considerable time. Three and a half months later an operation was done that seems to have included raising some periosteum and curetting the involucrum. Eighty days after this last operation, the face had again swelled and a very recently necrosed ramus was removed, showing little destruction at the time of operation. This early removal of the ramus was not followed by regeneration.

Persistence of the fistula necessitated two further operations, at one a dead tooth bud was removed from the ramus, and at the other a dead, partially developed crown.

The whole course as viewed in retrospect suggests a case of low-grade bone infection with slow separation of the dead fragments, and that the infection was spread and new areas of necrosis occurred as the result of the attack on the live bone. The premature



FIG 10—Case IX

removal of the ramus fragment was, in this case, only an incident, but if a failure of regeneration had occurred in the body similar to that in the ramus, it would have been a catastrophe requiring a subsequent bone graft. There is some retraction of the jaw, as a whole, on the affected side as shown in the photographs (Fig 1 A and B).

Figure 2 is of an X-ray taken June 16, 1925, eight years and seven months after the last operation, and at the age of thirteen years. The unerupted lower third molar is seen to be in proper relation to its opponent above and to the remaining part of the anterior border of the ramus. This would suggest that at least part of the retraction is due to shortening in the regenerated part of the body. It plainly shows the lack of the ramus, and also shows a somewhat deformed third molar bud.

CASE IV—Man, thirty years. Extensive necrosis with multiple sequestra.

First seen three months after original trouble, and found to have widespread necrosis, with between twenty and thirty pieces of sequestrum buried in separate pockets in the involucrum in the body and ramus (Fig 3). The operations were done over a period of time extending from seven and a half months to two and a half years after the onset of symptoms. There was recovery without diminution of the size of the mandibular arch, but all the teeth were lost. This case would tend to show that the long-delayed operation in adults would not save the teeth. However, the jaw is already developed and the saving of the teeth is not as important as it is where their presence is to be counted on to help preserve the length of the developing jaw.

CASE V—Girl, twenty years of age, who had loss of all tooth buds at five years as a result of necrosis. The measurements made at the time of examination showed the body of the lower jaw to correspond to a normal jaw of about five years. We have

OSTEOMYELITIS OF THE SKULL AND FACE

observed other similar cases. A third molar is present, but this has had no effect on the development of the jaw (Fig 4)

CASE VI—Man, twenty-two years of age. Failure of regeneration of jaw after curetting operation on lower jaw for necrosis one month after a tooth infection.

Operation for necrosis at eight years of age. First seen at twenty-two years. The third molars were the only teeth that had developed with the resulting lack of development of mandible (Fig 5, A and B, showing deformity).

Figure 6, A and B, after cartilage and skin grafts to permit use of tooth-carrying prosthesis. Prosthesis made by Dr James A. Brown.

CASE VII—Girl, ten years. Extensive necrosis of mandible following filling of a tooth. Sequestrectomy delayed eight months, with preservation of some molar teeth that were in the necrosed area, and preservation of almost the normal length of the jawbone.

Two weeks after the filling of a tooth the tissues over mandible swelled, first on right, then both sides, pain, abscess opened, and loose anterior teeth extracted two

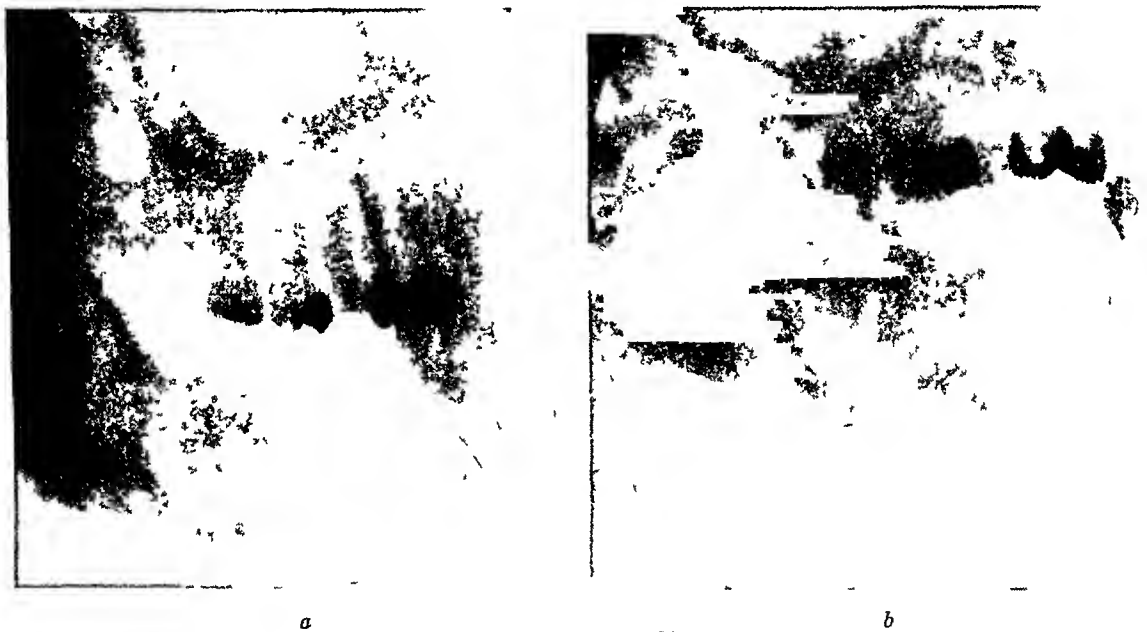


FIG 11—Case XI

months later. Pus continued to drain and was first seen at the Washington University Dispensary two months after first symptoms. X-ray condition at this time is shown in Fig 7A. It shows complete necrosis of the left side of body and ramus, the necrotic bone breaking into fragments, a fully erupted lower first premolar, and a partially erupted second premolar and second molar. New bone formation of the developing involucre can be seen on the mental part of the body, but an attempt to remove the sequestra would have resulted in the loss of all associated teeth, and most likely in a failure of development of new bone. Drainage had continued for five months, when the child was sent to the St. Louis Children's Hospital to determine if the continuous suppuration had or was likely to cause kidney or other vital damage. Doctor Marriott advised that he thought it safe to continue without at the present time removing the sequestra.

Figure 7, B, shows a well-developed involucre, and that the second premolar has either erupted further or is being thrown off. The developing crown of the third molar is also apparent. The masses of the sequestra are more clearly defined. It was in hopes of preserving some of the developing teeth that the sequestra were not removed at this time. The child was kept under careful observation, with repeated blood and urine examinations, three months longer. Eight months after first appearance of the symptoms, Dr. Earl Padgett (then an associate in this service) removed the sequestra and rongueured away overhanging bone. Child made a good recovery and the condition

one and a half years later is shown in Fig 7, C Both premolar teeth have been lost, but the second and third molars have continued to develop about normally There is a good strong body, but the only evidence of an alveolar process is about the second molar, which will be seen to be in approximately normal relation with its fellow above The base of the third molar is situated a little farther back than normal, but this seems to be the rule in jaws that have been necrotic On the report received as to present condition there was a question as to the possibility of a suppuration about one tooth, but there is no evidence of it in this radiograph The important point is that the jaw seems to have continued to grow and though there has been some question about its length, it is no shorter relatively than not infrequently occurs in children of her age who have had no bone infection, and with the normal molar occlusion preserved there is little likelihood of any increasing deformity developing Conditions on the right side about matched those of the left, but here the second molar was finally lost and the first premolar was preserved

Figure 8, A and B Photographs taken July 6, 1925 The scar can be taken care of

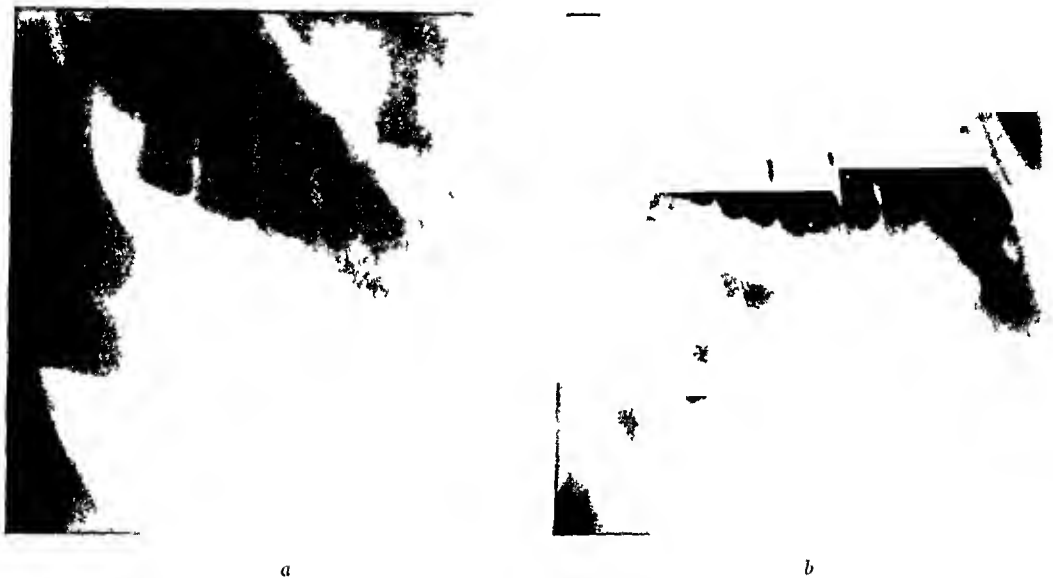


FIG 12—Case XIV

by removing the involved area down to the bone, undermining the edges, and then suturing them together

CASE VIII—Boy, twelve years Tightening of teeth that were loose in an infected jaw

X-ray three months after onset showed necrosis of right body back to second molar, with the first molar rising out of its bed, the cuspid, two premolars and second molar in the necrotic area The final sequestrectomy in this case was done four and a half months later, or eight months after the beginning of the trouble Six months later a report was received from the dentist that all the teeth mentioned were in place and tight except the first molar, and also that a third molar had erupted

This case is similar to Case VII in demonstrating the possibility of saving teeth and jaw symmetry in children by waiting long enough to remove the sequestrum The reason for this is that the tooth-bearing area in children does not sequestrate

CASE IX—Woman, thirty-three years Lack of development following extraction of teeth and some unidentified bone operations

Operations done at age of twelve years following necrosis from extraction of a tooth When first seen at age of thirty-three had a little nubbin of bone in the neighborhood of the right glenoid fossa, and 11 of the lower jaw on the left as far forward as the region of the cuspid tooth There was also some failure of development

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of the superficial tissues corresponding to the missing bone, and she had several bad teeth, which were pulled

Figure 9, A and B Showing deformity of jaw and lack of soft parts

Figure 10, A and B Appearance after skin and rib grafting and with prosthesis in place Prosthesis made by Dr James A Brown

CASE X—Boy, eight years Maxillary necrosis related to tooth infection, repeated early operations failed to control symptoms

Necrosis of maxilla following tooth extraction During the next few months there were five operations on the bone in an attempt to control the suppuration Eight months after the first appearance of symptoms there was a discharging fistula under the outer part of the left lower eyelid in a scar attached to the infraorbital border This scar mass was dissected out without identifying the sequestra and drainage established into upper fornix of the vestibule of the mouth No bone fragments were found, skin incision closed with small drain in place Child recovered with one mild return of

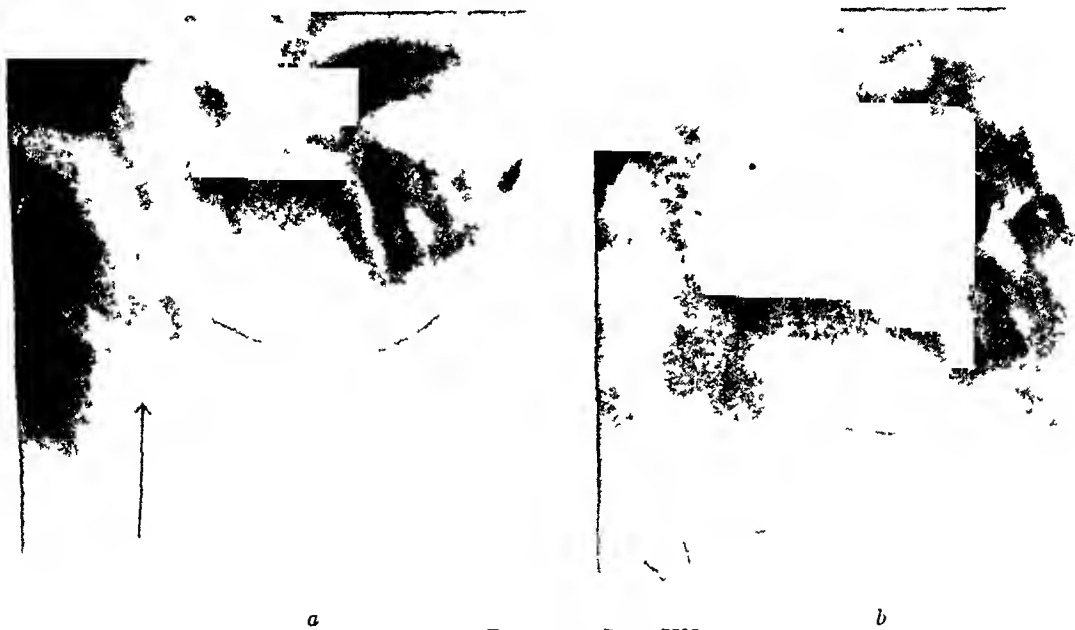


FIG 13—Case XV

symptoms about three months later Report by letter eleven months later states child is well

CASE XI—Woman, forty-eight years Antisyphilitic therapy and sequestrectomy after two years

Gland enlargement under jaw, tooth pulled, followed by persistent purulent discharge Wassermann negative, only suggestion of syphilis the otitis and two miscarriages without further pregnancies Blood-pressure over 200 Antisyphilitic treatment was given Two years later partial sequestrectomy done Six months after this there was still X-ray evidence of dead bone, but there had been so much improvement that waiting longer was advised Patient died that same month—apoplexy

Figure 11, A and B X-rays taken seven months apart show a progressive bone involvement

CASE XII—Man, forty-eight years Wassermann negative, but some relief of symptoms of pain and infection by salvarsan therapy Sequestrectomy finally done

Nineteen hundred and nineteen Soreness and tenderness in all molars and they loosened Nineteen hundred and twenty-one Molars pulled, three at a time, and later that year fourteen more teeth pulled at one time Pain and discomfort continued, and in February, 1922, it became very severe, and thick yellow pus drained into the mouth March, 1922, X-ray showed "moth-eaten" areas in all molar regions, most marked on right The remaining teeth were loose and rough bone could be felt in the lower

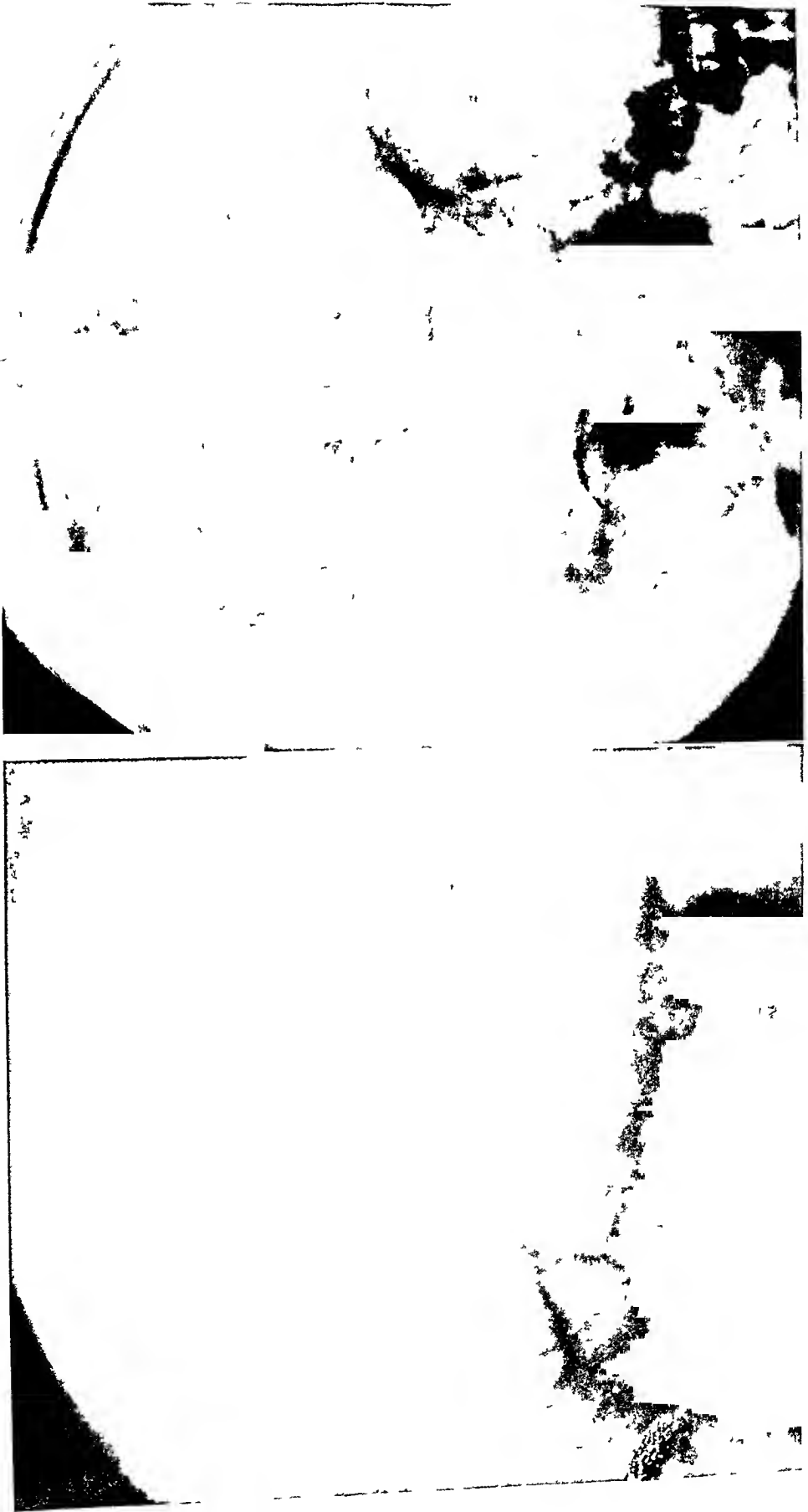


FIG 14 —Case 1A Shows moderate sized area of necrosis extending nearly to the vertex

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jaw Pain was a severe symptom throughout the course of the disease Diagnosis of necrosis was made with question of syphilis Several Wassermann tests were negative, but in November, 1922, there was reported marked improvement after antisyphilitic treatment of several months A clean easy sequestrectomy was done several months later

CASE XIII—Colored man, twenty-five years In 1909, at age of nine years, tooth broken in extraction, followed by pain and swelling There was one operation one year later He was treated for syphilis in 1924 First seen June 6, 1925 Left jaw swollen, poor occlusion, two sinuses present under jaw, and opening limited Incision made in front of ear, all tissues turned down, including parotid Dug out several pieces of dead bone, an impacted molar, and then the condyle and coronoid to give movement The mouth was still bound with a scar which was cut through

CASE XIV—Woman, thirty-two years Multiple extensive involvement of lower jaw with general symptoms that were not relieved until the last piece of dead bone was removed

She was in perfect health until dental trouble arose after some arsenic had been left in a tooth for two weeks There was local abscess and many teeth became loose Widespread necrosis (Fig 12, A) followed, many teeth were extracted, external drainage was done, and several sequestrectomies There was local neuralgia, for which two nerve injections were done There was also rheumatism, which cleared up, and there was a good general recovery after the last piece of dead bone was removed (Fig 12, B)

CASE XV—Woman, thirty-four years Following an inlay filling of right lower first molar, pain continued, and tooth was removed with excess trauma one month later Pain and swelling for months, many small pieces of bone were removed, and jaws locked for months after removal of teeth on that side Symptoms continued over a year and a half X-ray shown in Fig 13, A, taken nineteen months after origin of symptoms, shows a spanner-shaped piece of dead bone lying in the substance of the body and lower part of ramus of the right mandible The live bone embraces the sequestrum very closely This, considered with the length of time the symptoms had been present, and the lack of the mention of pus in connection with any of the various manifestations, rather suggests an infection with an organism that is not prone to cause suppuration Most likely a streptococcus of low virulence

Through an incision along the lower part of the border of the ramus and lower border of body the tissues superficial to the bone were raised and a sub-cortical sequestrum was laid bare and removed with a chisel All granulation containing tunnels was converted into shallow grooves, and the soft tissues were sutured back into place with rubber dam drainage

Patient discharged from hospital four days later, and at no time from then until the second operation was she entirely free from pain, swelling, slight fever, or discharge, though the wound had been re-opened, packed, and wet dressings maintained An X-ray taken three and a half months after the first operation (Fig 13, B) shows the channel from which the sequestrum had previously been removed, but no further evidence of necrosis or sequestra Four months after the first operation the whole area was laid bare, revealing the channels filled with granulations, wound packed, and Dakin treatment maintained for some time The packing was continued for two and a half months, and when the wound had healed the pain and low fever continued Later, the inferior dental nerve was injected with alcohol which for the time, at least, relieved the pain No further observation of the case

Diffuse Osteomyelitis of the Skull of Sinus Origin—Most of the recent rhinological literature supports very early and radical operative treatment of the necroses of the skull bones that may follow or accompany para-nasal sinus infections, and a powerful array of facts and figures are cited to support this contention This reversal of the more generally accepted rules for the treatment of osteomyelitis is not supported by our own clinical limited obser-



FIG 15 —Case IIA Shows extensive rarefaction of frontal bone and some roughening of the parietal region

vation of these cases Therefore, we have dug rather deeply into the literature of the subject reviewing over a hundred articles or detached case reports

In reference to the literature these seem to be the facts as we have them The first cases definitely reported as being of sinus origin were in 1899, one by Luc¹ and one by Tilley,² but there are a few reports of osteomyelitis of the skull giving practically the same clinical picture, in the literature farther back³⁻⁸

The radical writings consist of some twelve to fifteen articles, based partly on personal observations and largely on citations from an exhaustive article, in three parts, by Dan McKenzie, of London, and at the time of the appearance of his articles, 1913, editor of the *Journal of Laryngology, Rhinology and Otology* The latter writer deduced his conclusions from the study of forty cases that he found in the literature, and from one case of his own His findings were in the main that the cases (twenty in all) in which the necrosis developed after a sinus operation, died regardless of treatment, that of the twenty-one cases developing spontaneously from sinus infection, seven survived, and all of these seven had been subjected to "appropriate surgical treatment," which, from his article, we are led to believe was early radical bone removal

This is a rather formidable array of facts against which to argue, and his conclusions, which have had wide acceptance, especially among the rhinologists, are in harmony with his findings

We have been unable to substantiate all of his findings by referring to the literature

Four of his cases were definitely described as having had radical treatment But, in going over the cases, we find that

One described by Luc was still active after ten months McKenzie himself, in a discussion of a case report of Mollison's said that at least six months should be allowed to pass without any symptoms before deciding that the case is cured, and other observers put the period as high as eighteen months

Downey's recovery case was a chronic one of six years' duration, there was not a very widespread necrosis, and further it was said to have been a syphilitic case



FIG 16a —Case IVA —Shows area of involvement before an attempt was made to cut around it



FIG 166 and c —Case IV.1 Show the wide extension of bone involvement following an attempt to cure the patient by cutting out the diseased bone

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Syphilitic cases should not be recorded with these cases, as McKenzie himself said in throwing out one reported cured by conservative methods by Spicer

Davis' case, quoted by McKenzie, seems to have been a post-operative case, and to have recovered with very conservative treatment

McCoy, 1910, reported a post-operative case that recovered with fairly conservative treatment

Coffin, 1908, reported a case as cured of the osteomyelitis by operation, but also stated that the patient died. It is not clear to us whether McKenzie reported this as cured or not

Harrison, 1912, reported a case of mastoid origin as having recovered with very conservative treatment and emphasized the importance of waiting for sequestra to form, of supporting the patient in general, and of using vaccines

In our study of the literature appearing after these articles of McKenzie's, we found twenty-five cases reported, twelve following sinus operations, twelve arising spontaneously during the course of a sinus infection, and one after trauma

We have had six cases of this type, five arising from the frontal, and one from the sphenoid sinus. This series we consider rather small upon which to base sweeping conclusions, but of those who have so vigorously advocated early radical treatment no one had more than four cases

Tilley² reported four cases, all treated radically, one lived, and three died

Kernan¹⁰ reported two cases, one treated conservatively that lived, and one treated radically that died

Porter¹¹ reported one case following a sinus operation treated radically that lived for one year and then died of pneumonia. This is said to be the first post-operative case to recover

Mollison¹² reported one case treated radically that lived, but at the time of the report not enough time had elapsed to be sure of a cure

McClay¹³ had three cases, one living, but no details of the treatment were found, one living following multiple operations over a period of six months or more, one dead two months after a nasal operation without further bone cutting operation

Skilern¹⁴ reported one case that died after radical treatment, but concluded that radical treatment was delayed too long

Bryan¹⁵ reported one case, dead after removal of involved bone with curette, and one case living after ten or twelve months

Milligan and Wrigley¹⁶ gave one very short report of a patient recovering after radical operation

McArthur¹⁷ reported one fatal case without operation, but concluded that radical treatment was the best. However, he also stated that his case was too far advanced with involvement of bone in the ethmoid region for any treatment to be of avail

Warren,¹⁸ one case, reported living after bone cutting operation, but reported after only about six months of observation

Wood¹⁹ reported two cases with death of both, following radical treatment. States that operations were too limited and too long delayed

Bulson,²⁰ one case living following reported radical treatment. The operation, however, was two and one-half months after the development of the disease, a time at which the diseased bone might have begun to separate spontaneously

Eckstein²¹ reported a fulminating case that died on the same day of radical operation

Coffin,²² as cited in previous footnote

Turner,²³ one case, died after radical operation, and the author concluded that conservative treatment was best

Van Den Wildenberg,²⁴ one case, death following radical treatment

Von Eicken²⁵ two cases, one dead following radical treatment, one dead from brain abscess, without much radical surgery

Wolff Freudenthal,⁸ one case, reported well six weeks after radical treatment

McKenzie,⁹ one case of limited necrosis, bone removed, death

Patterson,⁷ one case living after twelve operations of undetermined nature

Tod,²⁵ one mastoid case, dead after radical operation on involved bone

Kuapp,²³ one case, dead after fairly radical surgery

Thompson,⁹ two cases, death of both following operations. Concluded that no kind of operations would stop the process, and mentioned one case that died after eighteen months

McCoy,²¹ two cases, one dead after radical treatment, one living after fairly conservative treatment

Not all observers report favorably to the radical bone cutting plan of treatment

Harrison²² reported the case described in preceding footnote

Thompson,²¹ as recorded here, concluded that the most vigorous treatment would not stop the process

Le Mere²⁴ reported a case treated conservatively that died, but his conclusions as to the treatment of choice are not clear to us

Kernan¹⁰ leans somewhat to the conservative side, at least for chronic cases

Opdyke¹¹ reported one post-operative case living after what seems to have been conservative treatment

Lynch⁴ reported one living with conservative treatment, but too soon to be sure of

Turner²³ turned to the conservative side after losing a case treated radically, and said "once an osteomyelitis of the frontal bone is set up, surgical cure is practically hopeless"

Symonds¹⁷ case in 1910 appears to have been treated by sequestrectomy

Mosher, H P, in a discussion of a paper by Bulson, sounds the same warning of conservatism that is attempted in this paper. He bases his views on observations of a case in which the osteomyelitis progressed after every radical surgical attack, but cleared up entirely under conservative treatment

In the literature before 1899, at which time cases were first recognized as coming from the sinuses (except the mastoid), there are many reports and discourses on osteomyelitis of the skull bones. After discarding those definitely thought to be tuberculosis or syphilis of bone, some of the others must have been of sinus origin, though unrecognized as such

Hewitt,³ in the *Lancet*, 1864, has a long discourse on disease and necrosis of the skull bones, and emphasizes that loosening of the dead bone should be waited for and, except in cases with very limited involvement, radical surgery should never be done. The main object should be to support the patient

Smith,⁴ 1870, reported a case of spontaneous origin and separation

Gardner,⁷ 1865, reported a case with recovery following multiple sequestrectomies over a long period

Gelston's,⁶ 1847, case had full thickness necrosis, and died of meningitis after it was opened

Hill,⁷ 1843, had a long drawn-out case of supposedly traumatic origin that was free of symptoms after a widespread operation twenty-five years after onset

Marks,⁸ 1894, reported a case during conservative treatment, but it was still slightly active at the time of the report

Of our six cases 1-A—One spontaneous frontal sinus case treated by late removal of the exfoliated bone survived and has been well for the past nine years, except for epilepsy, which is not related to the sinus trouble (Fig 14). Patient referred by W E Sauer

2-A—One frontal sinus post-operative case had twenty-one drainages or removals of exfoliated bone died of thrombosis of an emissary vein after subsidence of all local symptoms and he had been sent home (Fig 15). Patient referred by V V Wood

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3-A—One spontaneous frontal sinus case died of purulent meningitis after conservative treatment for three months by her family physician Referred by J M McClelland

4-A—One frontal sinus case treated for eleven months by ten operations (the second one radical, and followed by further spread of the disease) and five blood transfusions When he became so exhausted that further surgery was not to be considered, he was put on salvarsan (Wassermann negative) and milk injections, and improved so rapidly that he left the hospital in a month and has been working on his farm for the past five years (Fig 16, a, b, c) Referred by W E Sauer

5-A—One frontal sinus case treated conservatively had infections in two other parts of the body that may have been metastatic, but at present his head has healed and has been so for about a year This case is still under observation and is not yet considered cured Referred by Birsner

6-A—One sphenoid case (none others found in the literature, except some of direct perforation of the bone), who died of meningitis with widespread necrosis of the base of the skull Actinomycosis was found in conjunction with real pus Referred by G H Copher

While we had but two cases to survive out of five that we were able to follow to a conclusion, we are not yet ready to accept the more modern teaching of early, radical bone removal for these cases, and until more conclusive evidence is adduced, will continue to apply the older rules of hygiene, drainage, and the removal of exfoliated bone To these we would add an attempt to raise the patient's resistance to an apparently low-grade infection that seems to cause insufficient tissue reaction to expel it, but which, like the rats we tolerate in our back yards, may be very deadly to the complacent host Later, we may be able to make some report on the type of infection, and now have some observations

In the future we will add general quartz light treatment

ANALYSIS OF JAW CASES

Number of Cases 18 Children, 21 Adults (11 Male, 10 Female)

Cause	<div style="display: inline-block; vertical-align: middle; font-size: 4em; line-height: 1;">{</div> <div style="display: inline-block; vertical-align: middle;"> <p>Apparently associated with periodontal infections, 33</p> <p>31 of these were associated with extraction during acute state of a periodontal infection Of these 31 acute infections, there were 2 following devitalization of the pulp with arsenic, and 1 following application of phenol to the pulp chamber</p> <p>1 associated with salivation, HgCl</p> <p>1 associated with extraction of an old root</p> </div>
Other causes than teeth, 6	<div style="display: inline-block; vertical-align: middle; font-size: 4em; line-height: 1;">{</div> <div style="display: inline-block; vertical-align: middle;"> <p>1 associated with gland enlargement and loosening of teeth</p> <p>1 following tonsillitis</p> <p>1 following measles</p> <p>1 following diphtheria</p> <p>1 associated with tuberculosis elsewhere in the body</p> <p>1 associated with upper respiratory infection in an infant</p> </div>
Jaws effected	<div style="display: inline-block; vertical-align: middle; font-size: 4em; line-height: 1;">{</div> <div style="display: inline-block; vertical-align: middle;"> <p>Upper, 8</p> <p>Lower, 32 (both jaws in one case of suspected syphilis)</p> </div>

BLAIR AND BROWN

Wassermann	<ul style="list-style-type: none"> Negative, 17 No report, 18 Positive or partly positive, 4
Salvarsan	<ul style="list-style-type: none"> 8 cases 3 with negative Wassermann improved 3 with negative Wassermann, but no note of improvement 1 with positive Wassermann, but no note of improvement 1 with positive Wassermann, but treated before jaw was operated on (2 cases with positive Wassermann had HgCl—2 and KI treatment only)
Time elapsed between the appearance of first symptoms and the spontaneous throwing off, or the operative removal of sequestra in various cases	<ul style="list-style-type: none"> 1 at one week, bone-cutting operation on upper jaw—death 1 at three weeks spontaneous separation, upper jaw 2 at one month 2 at two months 8 at three months 7 at four months 8 at five months 8 at six months 8 at seven months 1 at eight months 5 at nine months 3 at ten months 2 at eleven months 1 at twelve months 1 at seventeen months 1 at twenty-four months 2 at thirty months 1 at thirty-four months 1 at eleven years
A total of 63 sequestrectomies, 8 of which were spontaneous	
Number of operations	<ul style="list-style-type: none"> 25 cases—only one operation was necessary 14 cases—multiple operations, but about half of these were external drainages
Deaths	<ul style="list-style-type: none"> 1 baby, following a bone-cutting operation on the upper jaw one week after the onset of symptoms

ANALYSIS OF OSTEOMYELITIS OF SKULL CASES

Authors 33		No cases with available records 46 (2 mastoids)	
Radical	23	Radical Treatment	37
Conservative	9	Dead	25
Undetermined	1	Living	12
		Of the 12 living, 5 were reported too soon to be sure of, and in one there was a question as to whether the treatment was of a radical kind or not	
		Conservative Treatment	9
		Dead	3
		Living	6
		Of the 6 living cases, one was a mastoid, one was a fairly limited case, and one was reported too soon	

OSTEOMYELITIS OF THE SKULL AND FACE

ANALYSIS OF OSTEOMYELITIS OF SKULL CASES—*Continued*

Age		Wassermann	Vaccines used in
Up to 10 — 6		Negative 16	5 cases of those that recovered with radical operation
10 to 20 — 9		Positive 0	
20 to 30 — 18		Anti-syphilitic treatment	
30 to 40 — 10			
40 to 50 — 2		9 without results	2 cases of death with radical operation
60 — 1		1 with vaccine and radical operation, recovery	
Male	Female	1 with sequestrectomies but reported too soon	1 with sequestrectomies with recovery (mastoid case)
28	18		

Bacteriology, reported here as designated in reports			Cause of death	
Staph	3	Proteus-Staph -Short Chain	Basalar meningitis	1
Strep	5	Strep	Meningitis	11
Staph Aureus	5	Mixed with Strep in short	Brain abscess	12
Staph Albus	2	chains	Throm Sup Long Sinus with	
Short Strep	1	Strep -pneumococcus	Meningitis	1
Non Homo Strep	1	Staph -Gram-ng Bac	Pyemia with lung involvement	1
Enterococcus	1	Staph -Albus-Strep	Pyemia with meningitis	1
Actinomycosis	1	Strep -Gram-pos Diplo-	Cavernous sinus thrombosis	1
Pneumococcus	1	coccus	Septic embolism of lung	1
		Staph -Strep	Lat Sinus throm with meningitis (mastoid case)	1
				2

CASES SINCE 1913-25

Origin	Frontal, 19	Frontals and others, 4	Antral-frontal, 2	Spontaneous, 12	Post-operative, 12	Trauma, 1
Radical treatment	Dead, 11 Living, 8 3 reported too early, 1 operated on after 2½ months' time					
Conservative treatment	Dead, 2 Living, 4 1 reported too early					
Osteomyelitis recognized	Before operation					21 cases
	At time of operation					2 cases
	No note					1 case
	Outer table uninvolved and extent of inner table involvement missed					1 case

ANALYSIS CASES OBSERVED HERE

Age	10, 10, 17, 20, 20, 33			
	Male, 3 Female, 3			
Wassermann	Negative, 4 No report, 2			
Salvarsan treatment	3 cases, 2 died 1 lived			
Bacteriology	Strep 2 Short chain strep, 1 Strep-staph, 1 Actinomycosis with a pus producer, 1			
Origin	Spontaneous, 4 Post-operative, 2			
Sinus of Origin	Frontal, 5 Sphenoid, 1			
Treatment and Results	Conservative in 6 cases 3 dead 2 cured There was some bone cutting done in one of these that was immediately followed by spread of the disease 1 still living after one year with head healed, but too early to call a cure			

BLAIR AND BROWN

REFERENCES

- ¹ Luc B M J, October 14, 1899, p 993
- ² Tilley B M J, October 14, 1899, p 994 B M J, July 7, 1917 B J L R O, 1923, p 78
- ³ Hewitt Lancet, 1864, p 205
- ⁴ Smith, T Trans Clin Soc Lon 1870, p 163
- ⁵ Gardner Bost M and S J, 1865, p 495
- ⁶ Gelston Dublin J of M Sc, 1847, p 271
- Hill, O Bost M and S J, 1843, p 119
- ⁸ Marks St Louis Med Courier, 1894 p 111
- ⁹ McKenzie B J L R O, 1923, 3 Parts
- ¹⁰ Kernan Trans Am Laryn Assn, 1921, p 330
- ¹¹ Porter Lancet, January 31 1914
- ¹² Mollison Proc Roy Soc Med, 1916-1917 B J L R O, September, 1918, p 276
- ¹³ McClay B J L R O, June, 1917, p 186 October, 1921, p 478
- ¹⁴ Skillern Trans Am Larynx, 1920, p 116
- ¹⁵ Bryan Am Journ Med Sci, 1920, p 687 Trans Am Laryn Assn, 1925, p 256
- ¹⁶ Milligan and Wingley B J L R O, July, 1924, p 401
- ¹⁷ McArthur M J Australia, 1922, p 410
- ¹⁸ Warren M J Australia, November 10, 1923
- ¹⁹ Wood Trans Am L R O, 1919, p 122
- ²⁰ Bulson J A M A, January 23, 1926 Trans Amer Acad Ophth Otolaryn, 1925 p 103
- ²¹ Eckstein B J L R O (abst), 1914, p 275
- ²² Coffin Trans Am Laryn Assn, 1908, p 164
- ²³ Turner Edm M J, 1905, p 239
- ^{24, 25, 26, 27} From McKenzie⁹
- ²⁸ Tod B J L R O, 1909 p 150
- ²⁹ Knapp Arch Oto, 1903, p 181
- ³⁰ Thompson Lancet August 12, 1905, p 431
- ³¹ McCoy Annals of O R L, 1910, p 287
- ³² Harrison B J L R O, 1912, p 628
- ³³ Lemere J A M A, March 3, 1923, p 596
- ³⁴ Opdyke Medical Record, January 1, 1916
- ³⁵ Lynah Laryngoscope, March, 1917, p 176
- ³⁶ Symonds B J L R O, 1910, p 33

BENIGN BONY ENLARGEMENT OF THE CONDYLOID PROCESS OF THE MANDIBLE¹

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IN THE last three years I have treated three cases of bony enlargement limited to the condyloid process of the mandible. A search of the literature several months ago succeeded in finding only one case which seemed comparable in any way to these, *viz* that recorded by Eckert.¹ Eckert's case has been mentioned and depicted (Fig. 1) by several other writers.^{2,3} Further trouble in looking up the literature has been spared by Gruca and Meisels who recently⁴ have collected 14 recorded cases and added three of their own.

CASE I—C. McH., female, married, age thirty-five, was first seen on March 21, 1924, gradually increasing swelling in the

region of the right mandibular joint, accompanied by a deviation of the chin to the left with malocclusion of the teeth.

Examination showed visible enlargement beneath the right zygoma, with some tenderness, but no definite mass could be felt on palpation. The right ascending ramus of the mandible appeared to be longer than the left, and the whole lower jaw was pushed toward the left, with consequent malocclusion of the teeth. There was no limitation of opening of the jaws, though some crackling could be detected in the joint region on the right side.

Radiographic examination showed the right condyle of the mandible to be irregularly enlarged to about three times the normal size. The left condyle was normal.

General physical examination shows a well-developed woman, with no other bony enlargements or other significant abnormalities. Wassermann reaction negative.

¹Read before the Philadelphia Academy of Surgery, October 4, 1926.

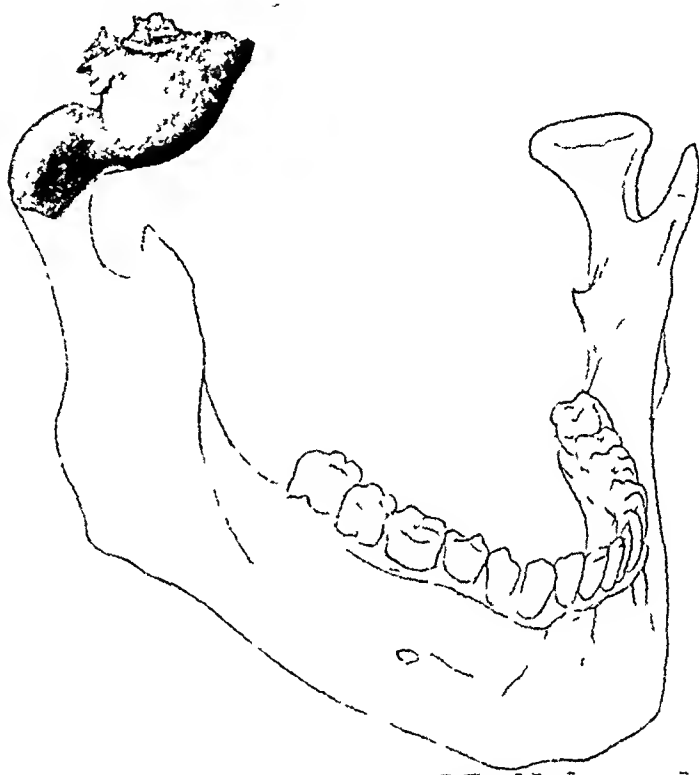


FIG. 1—Eckert's case of hyperostosis (Scudder)



FIG. 2—Enlarged condyle in Case I

April 1, 1924, under ether anæsthesia, through a Blair incision the right condyle of the mandible was excised by dividing its neck with chisel and mallet. The condyle was found to measure 3 cm in its transverse diameter, was thicker than normal, and presented a lobulated appearance (Fig 2). Histological examination revealed no evidence of inflammatory disease or pathological tissue of any kind—simply an overgrowth of bone and cartilage.

After the operation the mandible returned at once to its normal relation with the upper jaw, and after slight post-operative pain and tenderness in the wound the patient was discharged as well. A letter dated September 27, 1926, states that the patient has felt much better since the operation.

CASE II—R L, female single, age twenty-seven. Examined on April 28, 1925.

For about a year she had noticed a gradually increasing downward enlargement of the left side of the lower jaw, with little or no pain, although she suffered from headaches. She sought relief because the shape of her face was changing.

On examination it could readily be seen that the left side of the face was larger than the right (Fig 3), the chin being slightly deviated to the right. The left lower teeth did not come into contact with the upper teeth when the jaws were closed. There was no limitation of movement of the lower jaw. No masses could be felt, but the distance from the border of the zygoma to the angle of the mandible on the left side was 2.5 cm greater than the same measurement on the right side. No other abnormalities were found on physical examination.

Radiographic and ocular examinations for pituitary disease were negative. Wassermann reaction negative. The X-ray showed a well-defined antero-posterior enlargement of the left condyle of the mandible with smooth margins, the

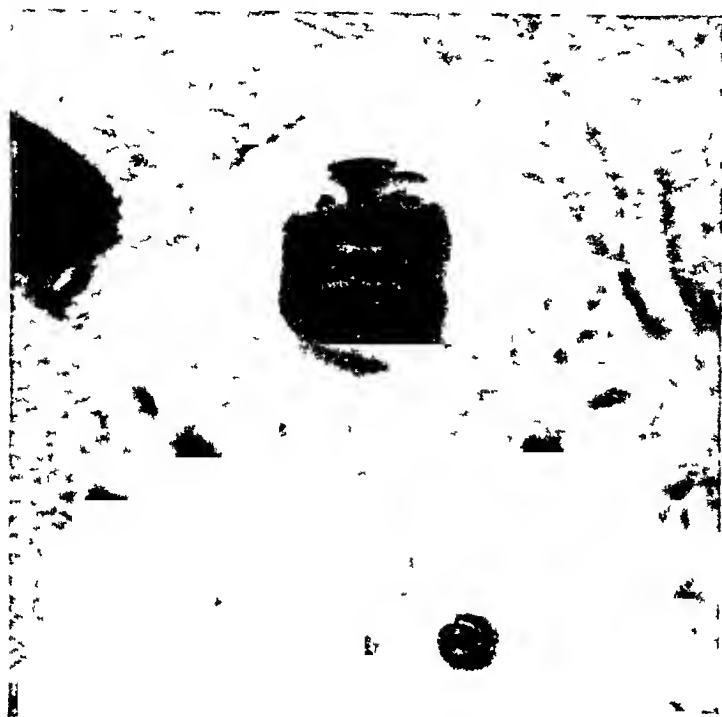


FIG 3—Case II, before operation showing enlargement of left side of face



FIG 4—Case II Radiograph showing enlargement of left condyle

ENLARGED CONDYLE OF MANDIBLE

coronoid shadow being much lower than normal (Fig 4) Four months later the patient returned complaining that the deformity was increasing and that she was beginning to have pain in the region of the left mandibular joint August 28, 1925, under colonic ether anæsthesia, through a Blair incision, the neck of the left condyle was exposed and the condyle excised with chisel and mallet There was found a uniform bony enlargement in all directions Unfortunately the specimen was cut to pieces in the laboratory Dr E A Case gave the following report of the histological examination "The bone is enlarged and denser than normal There are dense trabeculæ, and marrow spaces containing a rather cellular bone-marrow Beyond hypertrophy and an increase in density, the bone is not diseased histologically"

After operation, the facial deformity disappeared completely (Fig 5) The normal occlusion of the teeth was restored, although the patient complains of discomfort in mastication and vague pains about the head

Bony enlargements of condyloid process present a definite clinical syndrome, *viz*, slowly progressive vertical elongation of one side of the face, produced by lengthening of the ascending ramus of the mandible, the chin being pushed over toward the opposite side, failure of the upper and lower teeth on the affected



FIG 5 —Case II Patient after excision of enlarged condyle showing return of facial contour to normal

side to meet, and little or no interference with motion of the jaw Gruca and Meisels discuss various views as to the etiology and pathology of this condition Some of the reported cases suggest that middle-ear infection may stimulate an inflammatory hyperplasia and overgrowth of the epiphysis, but nothing definite is known as to the cause The disease has been classified as osteoma, exostosis, hyperostosis, hypertrophy, inflammatory process, while Gruca and Meisels term it "overgrowth" In the two cases reported here there was no evidence of inflammation or true tumor formation

Most of the recorded cases were successfully treated by the method employed here, *viz*, excision of the enlarged condyle

CASE III —This case differs somewhat from the others The patient was a woman, aged forty-eight, seen on May 18, 1925

Three years previously she first noticed discomfort in the region of the left man-

dibular joint, which for several months had amounted to severe pain at times, accompanied by difficulty in opening the mouth

Examination showed slight fulness and tenderness over the left mandibular joint, and considerable limitation in opening the jaw, on account of pain caused by movement. The patient was edentulous, making it difficult to determine whether the jaw deviated to the opposite side. At any rate, this sign, if present, was insignificant. There was no lengthening of the left ascending ramus.

X-ray examination (Fig 6) showed an oval enlargement bulging out the anterior aspect of the left mandibular condyle. The enlargement had a well-defined margin enclosing an area of less density than the surrounding bone.



FIG 6—Case III Cystic enlargement of left mandibular condyle

the surface of the cavity. No giant cells or tumor cells of any kind were found.

The operative wound healed in one week, without complications. One month after operation the patient stated that she was without pain, but that her jaw was still stiff and could not be opened wide. This is to be expected such a short time after operation. In a letter dated September 28, 1926, patient states that she now has no discomfort whatever in her jaw.

This third case differs from the others in that the overgrowth was cystic rather than solid. The literature records no cases of bone cysts limited to the condyloid process of the mandible. The principal symptoms were limitation of motion and pain, rather than visible deformity.

LITERATURE

- ¹ Eckert, B. Osteoma des Unterkiefers. *Beiträge z. klin. Chir.*, 1899, vol. LXXIII, p. 676.
- ² Scudder. Tumors of the Jaws.
- ³ Perthes, G. *Verletzungen und Krankheiten der Kiefer*. Stuttgart, 1907, p. 127.
- ⁴ Gruca, A., and Meisels, E. Asymmetry of the Mandible from Unilateral Hypertrophy. *ANNALS OF SURGERY*, 1926, vol. LXVIII, No. 6 (June), p. 755.

CEREBROSPINAL FLUID LEAK DUE TO A FISTULA OF THE CISTERNA MAGNA

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CEREBROSPINAL fluid leaks occur very rarely and when they do occur they usually drain through the ears, it follows that a direct fistula of the cisterna magna is a very rare condition and one that offers an unusual opportunity for studying the effect of various drugs upon the fluid. For this reason we are reporting the following case, in which the patient suffered a stab wound of the posterior cervical region which presumably entered the cisterna magna, with a resulting fistula from which cerebrospinal fluid drained for seventeen days. On the twelfth day following the injury a cerebrospinal meningitis developed, from which the patient completely recovered. During the course of the illness gentian violet, phenolsulphonaphthalein, methenamina, and sodium salicylate were administered and observations were made on the effects of each upon the cerebrospinal fluid.

CASE REPORT—A well-developed and well-nourished male negro, twenty-eight years of age, unconscious and in first degree shock, was brought to the Louisville City Hospital, November 7, 1925. He had a stab wound of the posterior cervical region. A physical examination showed no other injury or abnormality. The stab wound was in the posterior midline and extended about six centimetres from the base of the skull downward and to the left. After the wound had been irrigated and closed with deep sutures, a rubber drain was placed in the dependent portion.

The following morning the patient had recovered from the shock and his condition seemed fairly good. Twelve hours after admission he vomited once, the vomiting being projectile in type. During the day the patient was quiet. For an hour during the evening he had pain at the site of the wound, but rested well during the night.

On the third day he had a convulsion which lasted for a few minutes and was followed by a severe headache. A profuse, clear, serous discharge, presumably cerebrospinal fluid, was noticed on the dressing. The temperature, which had been normal, rose to 99, the pulse rate was 88, respiratory rate 20. For the next twelve days the headache continued with periods of remission, the pain being fairly well localized in the temporal and occipital regions. During this time, the temperature ranged between 99 and 99.8, the pulse rate remained at 80, and the respiratory rate at 20. On admission the blood-pressure was Systolic 120, diastolic 60, three days after admission it had increased to systolic 160, diastolic 60, where it remained during the patient's stay in the hospital. After the third day the cerebrospinal fluid flowed freely from the wound. The wound was slightly infected but it healed readily, except for one sinus track through which the fluid escaped.

On the twelfth day the temperature rose to 101, the pulse rate to 90, and respiratory rate to 20. On this day a glass female catheter was passed through the sinus track to the bottom of the wound and a radiographic examination with a metal probe in the sinus track showed that the tip rested on the arch of the atlas. The drainage around

the catheter was blocked with flexible collodion, which held without leakage for about twelve hours. Repeated observations of the quantity of the cerebrospinal output showed that it remained fairly constant, about 400 c.c. daily. At the time the catheter was inserted a lumbar puncture of the spinal canal was made. The cerebrospinal fluid thus obtained was turbid and contained 400 leucocytes per cu. mm., 60 per cent being polymorphonuclear. Repeated punctures and bacteriological examinations of the fluid from the lumbar region revealed a non-hemolytic streptococcus, staphylococcus albus, and an unidentified Gram-positive bacillus. The spinal manometer reading in both the lumbar and the cervical regions was 16 mm. of mercury.

On the fifteenth day the temperature was 103.6, the pulse rate 110, the respiratory rate 28. The severity of the headache and its location were unchanged. Kernig's sign was positive. The pupils were normal. There was no change in the cerebrospinal fluid drainage and bacteriological examinations gave the same results as before.

On the seventeenth day the temperature, pulse, and respiration were normal and remained so thereafter. The drainage of cerebrospinal fluid stopped suddenly on the nineteenth day, while the glass catheter was still in the wound. The headache became very severe after the drainage stopped, but it could be fairly well controlled with aspirin and by limitation of the fluid intake. The symptoms gradually subsided and the patient was discharged from the hospital on the twenty-first day, apparently well.

The following observations on the cerebrospinal fluid were made after the administration of the indicated drugs.

Gentian Violet—Twenty c.c. of a one per cent solution of gentian violet was given intravenously. There was no visible coloring of the cerebrospinal fluid during a twenty-four-hour period of observation.

Phenolsulphonephthalein—One c.c. of phenolsulphonephthalein injected into the lumbar subarachnoid space, with the patient in a recumbent position, first appeared in the fluid draining from the cervical region in one hour and 20 minutes. Fifteen per cent was eliminated in the urine in two hours.

Methenamina—Thirty grams of methenamina administered per os appeared two hours later in the cerebrospinal fluid. It was necessary to acidify the fluid before the formaldehyde test was positive.

Sodium Salicylate—One hundred and twenty grams of sodium salicylate was administered per os. The quantity of the fluid output decreased ten c.c. during the next five hours, but this was within the variation in the rate of fluid loss at the time.

Discussion—According to DaCosta,¹ cerebrospinal fluid leaks rarely follow skull injuries. When they do occur, they usually follow basal fractures of the skull and appear in one or both ears, or after fractures of the frontal bones there may be a leak from the ears, the cerebrospinal fluid appearing, however, only when there is a break in the mucous membrane, the dura, and the arachnoid.

"Treves² states that cerebrospinal fluid cannot flow from the ear in fractures of the middle fossa—(1) unless the line of fracture crosses the internal meatus, (2) unless the prolongation of the membrane into the meatus is torn, (3) unless a communication exists between the internal ear and tympanum, and (4) unless the drum-membrane is torn."

Miles³ states that in a case in which the drum-membrane of the ear has been ruptured, cerebrospinal fluid may flow from the ear even when the skull is not fractured. In such a case, the cerebrospinal fluid flows inside the sheath of the auditory nerve, passes into the vestibule, through the lamina cribrosa, and from the vestibule into the middle ear, finding an exit through the rent in the drum-membrane.

CEREBROSPINAL FLUID LEAK

Dandy ⁴ states that three types of treatment have been tried in cases of septic meningitis

“(1) Repeated lumbar punctures (intermittent drainage), (2) continuous drainage from, (a) the spinal canal, (b) the cisterna magna, (c) the pontine cisterna, (d) the lateral ventricles, and (e) the subarachnoid space, and (3) irrigations of the subarachnoid space”

He considers that continuous drainage from the cisterna is the operation of choice, and he reports three recoveries in a series of four cases in which the patients were treated by continuous drainage from the cisterna magna

Moise ⁵ reports a case of staphylococcus meningitis secondary to a sacral sinus in which recovery followed treatment by lumbar laminectomy with drainage. He used drainage in this region because the infection followed the removal of a pilonidal sinus and this was considered the portal of entry

In our own case, meningitis was due to a mixed infection, the portal of entry being through the stab wound between the occiput and atlas. By keeping the wound open, continuous drainage from the cisterna magna was maintained. The infection was apparently not limited to the spinal region. Recovery took place before spontaneous closure of the sinus

Various experimental studies have been reported which were undertaken with the purpose of determining the effect of the administration of dyes upon the cerebrospinal fluid. Solomon ⁶ used phenolsulphonephthalein to determine the circulation of the cerebrospinal fluid with reference to the treatment of cerebrospinal lues. After injecting one c.c. of phenolsulphonephthalein into the lumbar subarachnoid space, he recovered the dye from the cisterna magna, where it appeared in from seven to seventy minutes. He then injected the dye into the cisterna magna and found that the average length of time in which it appeared in the lumbar subarachnoid space was ten minutes. The time consumed in the passage of the dye from the lumbar subarachnoid space to the cerebral ventricles averaged twenty-five minutes, and from three to fifty c.c. of fluid had to be withdrawn before the dye appeared. In one case it passed from the cerebral ventricles to the lumbar subarachnoid space in fifteen minutes, in two cases it passed from the cisterna magna to the cerebral ventricles in eight, and twenty-eight minutes, respectively. As a result of these observations and of an experiment to determine the diffusion of the cerebrospinal fluid, he offers the following conclusion

“There is a free communication between the lumbar subarachnoid space, the cisternal subarachnoid space, and the lateral ventricles. Under ordinary conditions, however, it is probable that there is not very much movement from one locus to another of the substances introduced into the cerebrospinal fluid. The movement of the introduced substances may depend either on circulation of the cerebrospinal fluid, or, what is more probable, on a diffusion of the substances due to osmotic and specific gravity effects”

Weston ⁷ made injections of one c.c. of phenolsulphonephthalein (neutral), with specific gravity 1.0061, in twenty-eight cases of catatonic dementia præcox and in seventeen cases of paresis. He did not find the dye in the

fluid drawn from the cisterna magna at any time up to five hours after it had been injected into the lumbar subarachnoid spaces. The period of time between the injections of the dye into the lumbar subarachnoid space and its appearance in the urine was used by Weston as a diagnostic sign. He found this period varied from twelve to sixty-eight minutes in cases of paresis, and from twenty-five to 104 minutes in cases of catatonic dementia præcox. From these findings he drew the conclusion that the absorption of the dye is from the lumbar region, and that it is delayed in these two diseases. The time of its appearance in normal individuals is stated by Dandy and Blackfan⁵ to be six minutes and by Mehrtens and West,⁶ four to ten minutes.

REFERENCES

- ¹ DaCosta, J. C. *Modern Surgery*, 8th ed., p. 888.
- ² Quoted by DaCosta *Loc cit*, p. 888.
- ³ Quoted by DaCosta *Loc cit*, p. 888.
- ⁴ Dandy, W. E. The Treatment of Staphylococcus and Streptococcus Meningitis by Continuous Drainage of the Cisterna Magna. *Surg., Gynec. and Obst.*, 1924, vol. *xxviii*, pp. 760-774.
- ⁵ Moise, T. S. Staphylococcus Meningitis Secondary to Congenital Sacral Sinus. *Surg., Gynec. and Obst.*, 1926, vol. *xliv*, pp. 394-397.
- ⁶ Solomon, H. C., Thompson, L. J., and Pfeiffer, H. M. Circulation of Phenolsulphonephthalein in the Cerebrospinal System. *J. A. M. A.*, 1922, vol. *lxxix*, pp. 1014-1020.
- ⁷ Weston, P. G. Phenolsulphonephthalein Absorption from the Subarachnoid Space in Paresis and Dementia Præcox. *Arch. Neurol. and Psychiat.*, 1921, vol. *v*, pp. 58-63.
- ⁸ Dandy, W. E., and Blackfan, K. D. An Experimental and Clinical Study of Internal Hydrocephalus. *J. A. M. A.*, 1923, vol. *lxv*, p. 2216.
- ⁹ Mehrtens, H. G., and West, H. F. Absorption of Phenolsulphonephthalein. *Arch. Int. Med.*, 1917, vol. *xxv*, p. 575.

OSTEOPLASTIC SUPPORT OF THE SPINE IN POTT'S DISEASE

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THOUGH the problem of a constant fixation of the section of the spine affected by tuberculosis is satisfactorily solved by means of a series of operations of a type similar to Albee's method of surgical treatment, this by no means may be said with regard to the support of the diseased vertebræ. Bitter experience, based on observations carried out for a great number of years, has led the majority of surgeons to the conclusion that it is indeed indispensable to wear orthopædic corsets for a long period even after an osteoplastic fixation of the diseased vertebræ in order to avoid increasing kyphosis. Unfortunately it is either impossible or too expensive for most patients to carry out systematically this post-operative treatment. Orthopædic corsets require systematical medical attention and repeated altering and repairing which is difficult or even impossible for people living at great distances from the surgeon.

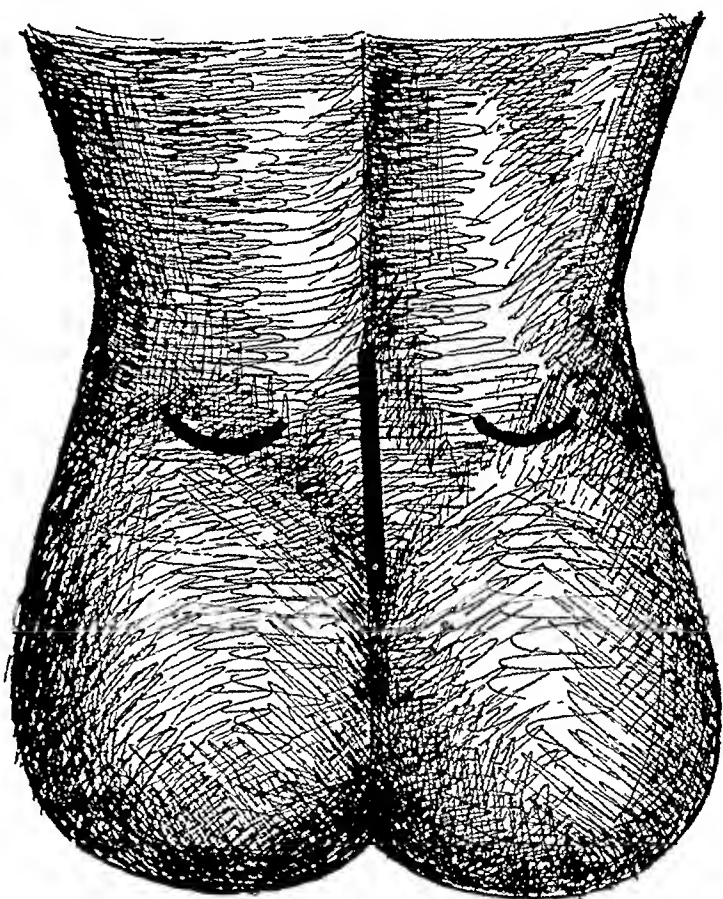


FIG. 1.—Showing three relative positions of the iliac crests and the lumbar spines

And in Russia it is entirely impossible, owing to a lack of means, for the great majority of the population to purchase orthopædic corsets.

All these considerations have led us to seek a remedy by a surgical method of treatment which would in addition to immobilizing the affected section of the vertebral column also support it. This we found practically possible when the disease is located in the lower section of the vertebral column, *i.e.*, in the lumbar and the last two dorsal vertebræ.

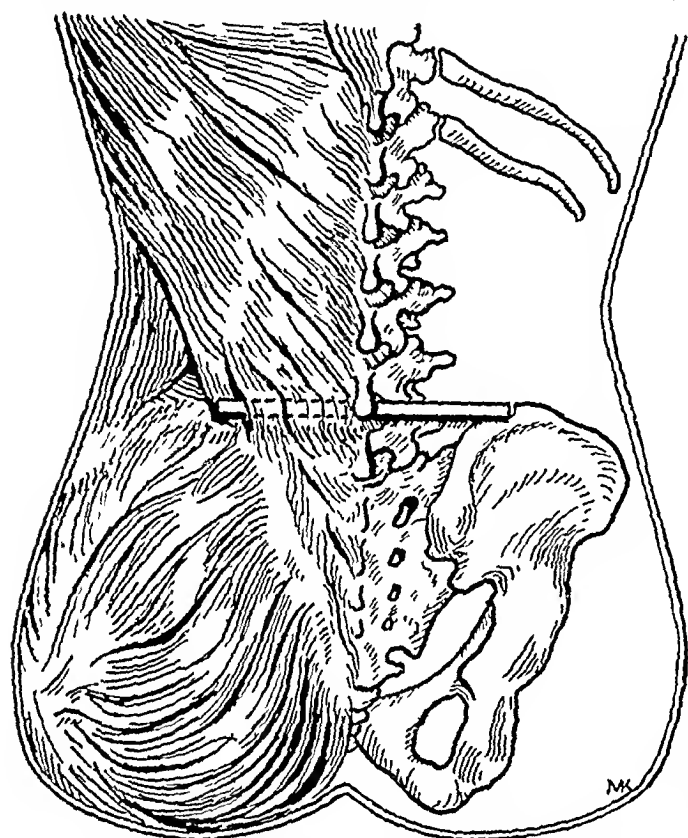
In such cases we transfer the weight of the trunk from the diseased vertebræ to the pelvis by the following operative methods.

I *The Method of Transverse Support*—This operation may be applied in cases of an affliction of both the IV and V lumbar vertebræ together or

of each of them separately when, owing to their sagging the spinous process of the IV lumbar vertebra is situated below the line connecting the uppermost points of the cristæ ili

The operation we present is made as follows

1 A longitudinal incision of the skin beginning at the apex of the spinous process of the second lumbar vertebra (L II) and extending to the junction between the upper and medial thirds of the sacrum (Fig 1)



2 The fascia lumbo-dorsalis is dissected at the sides of the spinous process L II, III, IV, and V perpendicularly to their oblique surface. Then the spinous processes and the arches of the three lower lumbar vertebrae are denuded of their periosteum

3 The ligamentum interspinale is dissected between L II and L III, the spinous processes of these vertebrae are dissected at their bases by means of Liston's forceps and reflected to the lower corner of the wound

4 A semi-crescentic incision with its convexity directed downwards is made on both sides of the vertebrae in the region of the uppermost points of the cristæ ili (Fig 1)

5 Having drawn upwards the skin flap formed by means of the above-mentioned incision, we vertically dissect the fascia lumbo-dorsalis at the medial corner of the wound and denude within the limits of the wound the crests of the ilium with a blunt dissector. Then a groove is made with a gouge on the upper margin of the latter

6 A firm, long, curved forceps is introduced at one end of this wound and passed beneath the muscle erector trunci, in a similar manner it is brought out through the analogous wound on the other side of the vertebral column. By opening the forceps we form beneath the above-mentioned muscle a broad canal

7 After measuring the space between the ends of the grooves in both cristæ ili, we form a raft of a similar length and $1\frac{1}{2}$ cm thick out of the cristæ tibiae

8 The end of this raft while being held by the forceps is passed

OSTEOPLASTIC SUPPORT OF THE SPINE

beneath both muscles *erector trunci* and beneath the spinous process L III and its ends are then placed in the grooves formed in both *cristæ illi*

9 The soft tissues which had been separated from (Fig 2) the *cristæ illi* are fastened over the ends of the *rafter* by several catgut sutures and the semi-crescentic incisions of the skin are sutured with silk

10 The spinous processes L IV and L V suspended on the ligamentum interspinale are, according to the amount of space either inserted beneath the middle of the *rafter*, or placed sidewise on the denuded arches of those *vertebræ*, or entirely removed

11 The soft tissues separated from the spinous processes and arches in the longitudinal wound are fixed with a series of catgut sutures placed one above the other as follows First, through the muscles and the adjoining periosteum, and next, through the fascia *lumbo-dorsalis* Then the skin incision is sutured with silk

As a result of this operation the weight of the trunk from the affected *vertebræ* is transferred by means of a powerful spinous process (L III) to a firm osseous *rafter*

After the operation is completed the patient is kept lying on his back for six weeks By the end of the second week he is allowed to rest for an hour or two daily, lying on his abdomen with a hard pillow placed under his chest

After six weeks the patient is gradually trained to sit and seven weeks after the operation he begins to walk, having no need of any kind of corsets

A support of the spine by means of an orthopædic corset in these instances is even contra-indicated, for owing to the effect of the load of the trunk the osseous *rafter* grows and consolidates more rapidly (as it has been proved by rontgenograms) whereas the *mm erectores trunci* placed over it appear to be a *vis a tergo* securing a reclinatio which is most important under the circumstances

II *Method of Oblique Support*—In cases of an affection of the last two dorsal or the first three lumbar *vertebræ* we perform an oblique support of

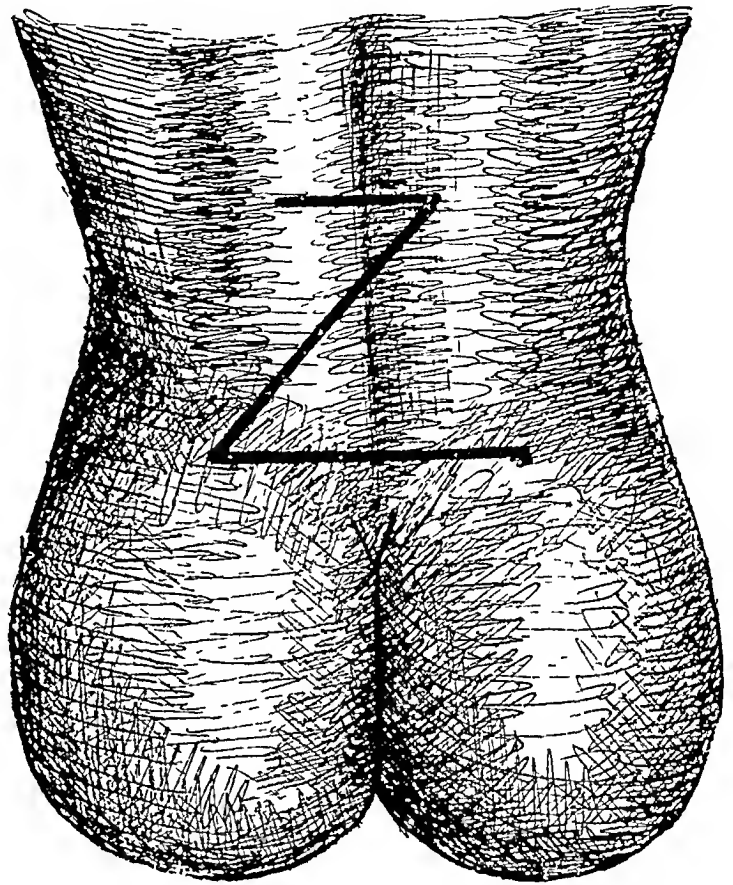


FIG 3 —Z-shaped incision to expose lower dorsal and upper lumbar *vertebræ*

the diseased section of the spine, creating a trestle consisting of two long osseous transplants and fixing the lower ends of the latter in *cristæ ili*. The upper ends of the trestle are fixed in a crosswise manner beneath the process of the sound vertebra which is situated above the diseased section of the spine.

We perform this operation in the following manner:

1 A Z-shaped incision of the skin is made with its lower horizontal part situated at the level of the *cristæ ili* and within the limits of the external margins of both *musculi erectores trunci*. The upper horizontal incision is

made parallel to the lower one and just above the spinous process which serves as a support. After the uniting oblique incision is made the triangular skin flaps are separated from the sub-lying aponeurosis and drawn externally (Fig 3).

2 The soft tissues are separated with a resection knife along both sides of the apices of the spinous processes beginning at the one which is

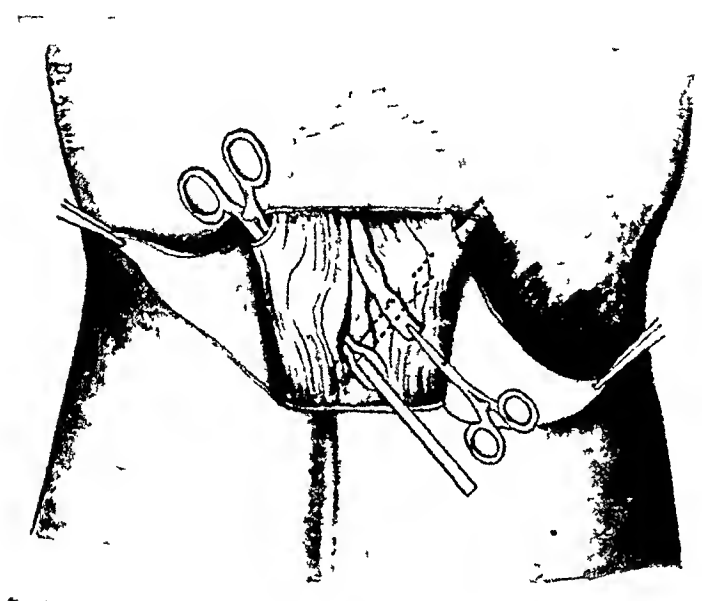


FIG 4 —Forming a canal in which the transplant grafts are to be lodged

to serve as a support, and reaching to the last lumbar vertebrae, parallel to the lateral surfaces of spinous processes and extending to depth of bone.

3 The spinous processes and the dorsal surfaces of the arches are denuded of their periosteum up to the transverse processes.

4 The *ligamentum interspinale* is dissected at the apex of that spinous process which is to serve as a support. All spinous processes situated below it are dissected at the base by means of Liston's forceps and reflected downwards.

5 At both ends of the lower horizontal incision the *fascia lumbo-dorsalis* is dissected by means of a vertical incision about 5 or 6 cm long penetrating to the *cristæ ili*.

6 A groove is formed by means of a groove gouge in the crest of the ilium on both sides of the spine for the purpose of fixing the lower ends of the transplantates.

7 A long firm forceps is passed through the above-mentioned incision in the *fascia lumbo-dorsalis* beneath the *muscle erector trunci*. This forceps being directed upwards is pushed beneath the spinous process which is to serve as a support. By opening the forceps we form a canal in which the transplantates are to be placed (Fig 4).

OSTEOPLASTIC SUPPORT OF THE SPINE

8 Having measured the distance between the apex of the spinous process intended for a support and the groove in the crest of the ilium and having added 2 or 3 cm for insertion and crossing, we form an osseous rafter of a corresponding length and 1 to 1½ cm thick out of each of the crista tibiae, gradually decreasing the thickness of the rafter almost to half of this size in the direction of the upper end of the transplantate

9 Both osseous rafters are introduced, the narrow end foremost, through the incisions in the fascia lumbo-dorsalis and into the canal formed beneath muscle erector trunci with the forceps until they cross beneath the spinous process which is to serve as the support. The upper ends of the transplantates are inserted beneath the muscles of the opposite side and the lower are placed in the groove formed in the iliac bones (Fig 5)

10 The vertical incisions in the fascia lumbo-dorsalis are sutured with catgut above the lower ends of the transplantates

11 The spinous processes which had been drawn downwards are then laid with their lateral surfaces

along the medial line up to the point of intersection of the transplantates

12 The long muscles of the back are sutured with catgut along the medial line in region of intersection of transplantates, ligamentum interspinale connecting spinous processes which had been dissected also included in suturing

13 The fascia lumbo-dorsalis is thoroughly sutured with catgut along the medial line above the muscular layer

14 The skin incision is sutured entirely with silk

The post-operative treatment and cure are identical with those used after transverse support of the spine. As in the first instance, the patients are allowed to sit six weeks after the operation, and to begin walking without corsets by the end of the seventh week

As yet we have applied this surgical method in only 10 cases, but judging from clinical observations and numerous roentgenograms our theoretical calculations have so far come true that we are convinced that this method of osteoplastic support will find a place in the surgery of the spine

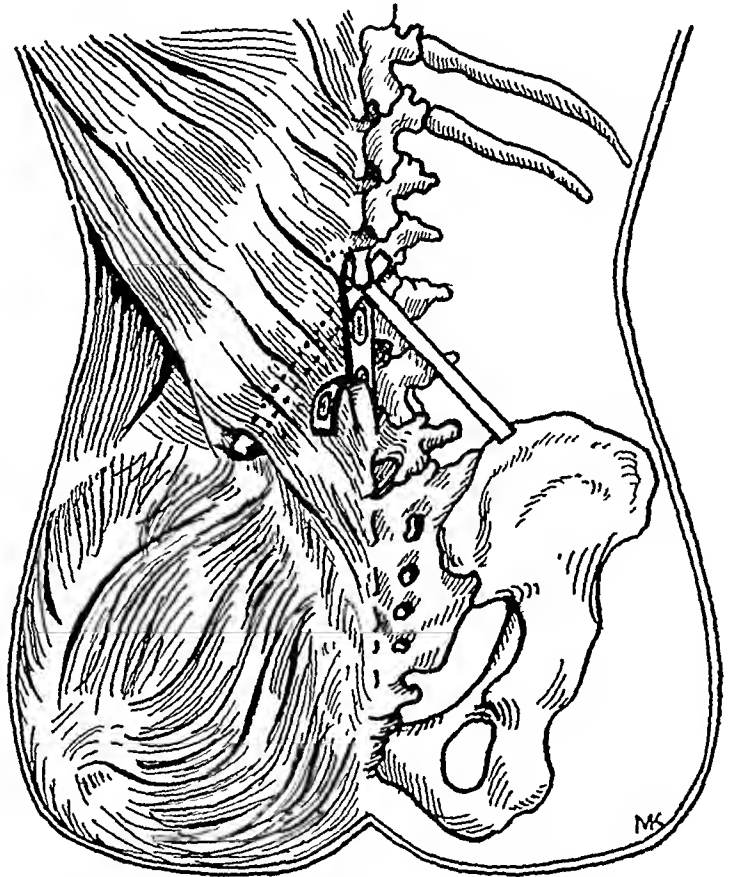


FIG 5 —Osseous grafts from tibial crests in place

OPERATIVE RELIEF OF LARYNGOSTENOSIS

By ARNOLD SCHWYZER, M D

OF ST PAUL, MINN

I WISH to report a case of laryngostenosis in the treatment of which a procedure was adopted which, apparently, has not been used before

A woman of about forty years, came to see us for a severe stricture of the larynx. She had been treated for one year, as she said, for asthma. There was such a formidable stridor that it seemed she might choke in the office. She was unable to speak above a whisper. A year previously she had started to lose her voice. A cough had come on at that time, and a very severe sore throat. She had lost 25 pounds in weight since that time. During the last six months the inspiration had become labored and prolonged, with a loud stridor. The dyspnea robbed her of her sleep. She was unable to run or even walk. She had been in good health according to her statement, until the present trouble began. There was no tuberculosis in her family. Her husband appeared to be very well and denied any venereal infection.

The laryngoscope showed a great destruction of the epiglottis, the larynx looked like an ulcer-

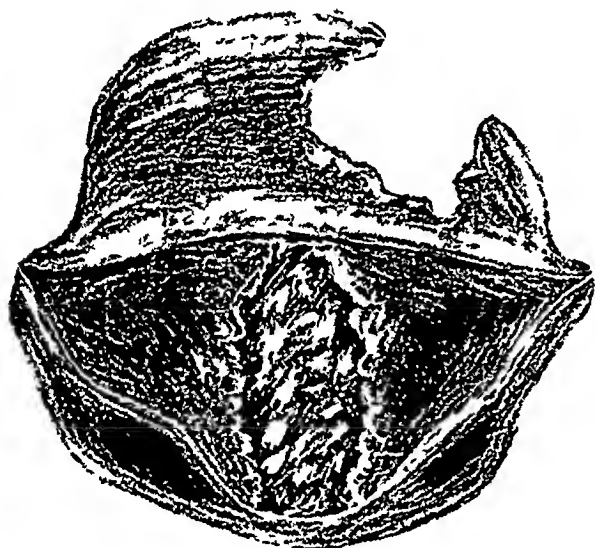


FIG 1 —Ulcerated and stenosed larynx

ating crater (see Fig 1). One could not see into the trachea, the larynx having a very narrow and tortuous lumen, and presenting on all sides, a bulky thickening, with an irregular ulcerated surface, partly covered with dirty looking material. A Wassermann test was ordered without delay and proved to be four plus. A salvarsan (0, 6) injection, followed by protiodide of mercury internally, caused a prompt change in the appearance of the epiglottis and the larynx, and also in the breathing and general condition. Within one week the patient could breathe easier, though dyspnea was still present. The epiglottis very soon appeared healed and was now pale, but the false and true cords could not be made out. All of the ulcerated parts were paler and cleaner. A cicatricial stenosing change seemed to go hand in hand with the healing, and was undoubtedly the cause that the dyspnea grew worse again after the first improvement. Soon her breathing became even as bad as before, although the larynx kept improving in appearance.

Six weeks after the first salvarsan injection, it became necessary to operate. The dyspnea was again very severe, almost extreme. Novocain 1 per cent, with eight drops of adrenalin to the ounce, was used for the skin and the muscles. Some of it was injected on each side into the area where the superior laryngeal nerve reaches the side of the larynx, and penetrates the thyro-hyoid membrane. The skin was incised two and a half

* Read before the Western Surgical Association, October 15, 1926

OPERATIVE RELIEF OF LARYNGOSTENOSIS

inches horizontally across the middle of the thyroid cartilage. The sterno-hyoid and thyro-hyoid muscles were cut through, and the thyroid cartilage was freed for one inch on each side of the midline. The patient laid with the head a little lower than the shoulders. Now before opening the larynx, the table was tilted to produce a moderate Trendelenburg position to avoid aspiration of blood. The cartilage was then divided in a zig-zag manner, which can best be understood by examining the sketches (Figs 2 and 3). Two projections were thus formed, one on each side, which met with their rounded and strong tips after the two halves of the cartilage had been pulled apart. By directing the incision so that the upper tooth had a slightly downward direction, while the lower one was pointing

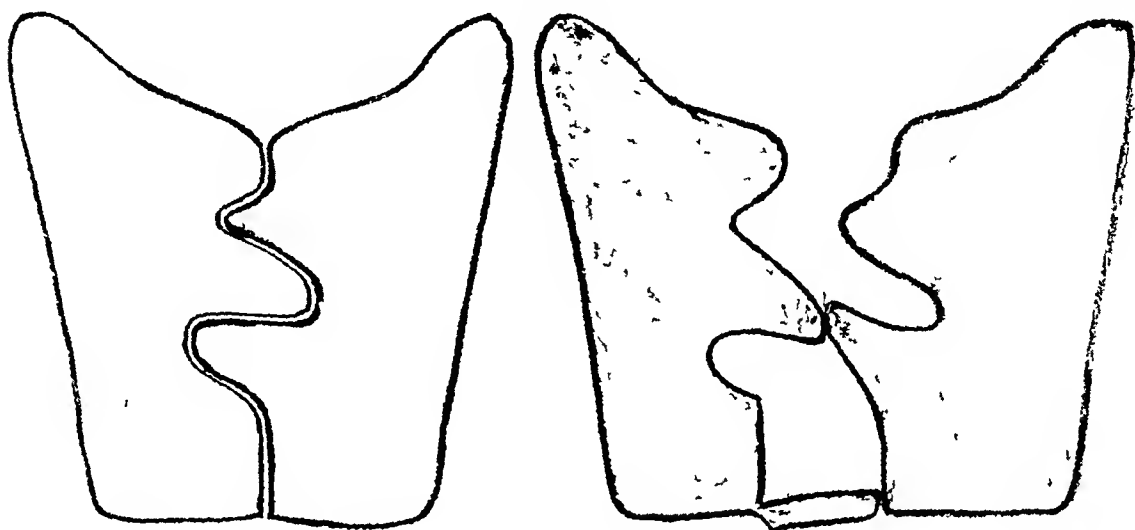


FIG 2 —Incision made into thyroid cartilage

FIG 3 —Incision, spread apart

a trifle upward, their tips met so that the lower tip was a little above the upper. We had carefully avoided opening the mucosa during this step of the operation. The breathing became improved even before the mucosa was cut. Novocain with adrenalin was now applied.

With a fine needle, we injected a few drops of a stronger cocain solution through the mucosa into the larynx before incising it, and waited a little while. The violent attack of coughing, which otherwise accompanies the division of the mucosa, was thus avoided. The larynx could then be rapidly opened by simply dividing the mucosa which had been thoroughly blanched and anæsthetized. There was practically no bleeding. We had observed on previous occasions, that the cartilage may well be cut without simultaneously opening the mucosa. This prevents serious bleeding into the air passages, and the very unwelcome fits of coughing that result.

The breathing became at once entirely free, through the wound. The stenosis was all in the larynx, none of it in the sub-glottic area or in the trachea. The cricoid remained therefore untouched. The two halves of the thyroid cartilage were now held apart with linen threads, and the whole larynx could freely be inspected. It was diseased down to the true vocal cords. The right false cord especially was protuberant, soft and flabby. It almost looked like an inversion of a Morgagni pocket, which, as you know, occurs as a definite pathological entity. This mass was grasped with a forceps and resected. Now attempts were made to splint the larynx with a short O'Dwyer intubation tube of adult size. It was, however, too short to engage sufficiently into the trachea. A long hard rubber intubation tube, marked for a child of thirteen years, was then inserted, and rested in place comfortably without pressure. Strange to say, the patient had ample air through it and was very satisfied with this much improvement of her respiration. She had been used to much less air for such a long time. The two sides of the thyroid

cartilage, as mentioned before, had been pulled apart till the tips of the two corresponding projections rested on each other. This caused a gap in the line of incision of seven or eight millimeters at the upper end, and about six or seven at the lower border of the cartilage. The two corresponding cartilage projections were now fastened by a silk suture, so that their tips met firmly. There seemed to be little danger of a slipping back into the original place, even should the thread soon cut through.

This procedure was surely much simpler and better than the implantation of a brace, which has to be taken from a distance and brought up by a long pedicle. Rather compli-

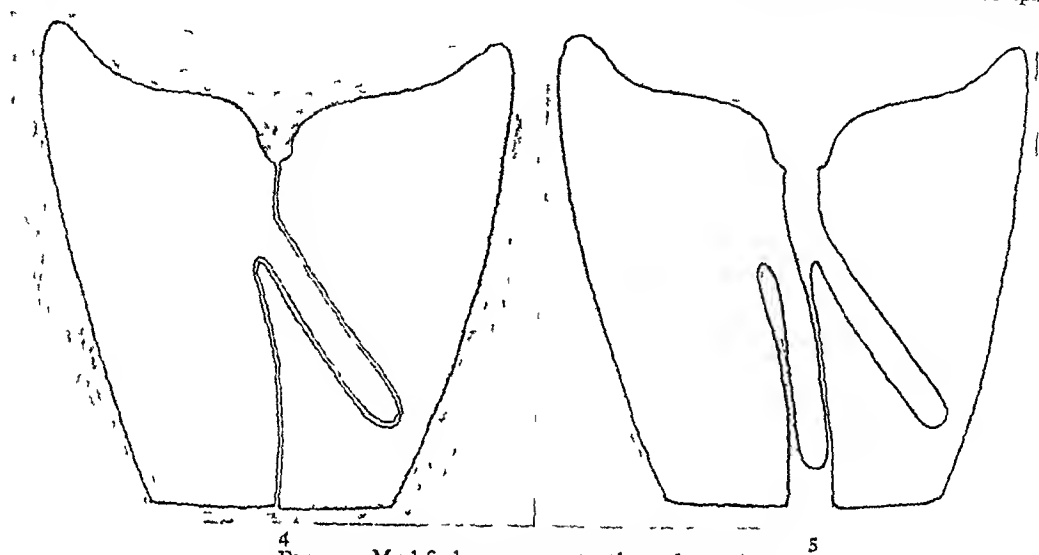


FIG 4 —Modified incision into thyroid cartilage
FIG 5 —Cartilaginous projection lifted over into the median cleft of the laryngofissure

cated operations have been tried with varying results. There is always much irritation and infection in these wounds, and the parts are greatly disturbed by the frequent coughing.

The lowermost portion of the incision in the thyroid cartilage, was vertical on account of the vocal cords. This was, however, just the region which might again become stenotic. Therefore, a small cartilage flap was cut by a vertical incision along the edge on the right side, the lower end remaining attached by its perichondrium. This piece was thrown across the lower part of the gap and fixed to the other side by a linen suture. To counteract the tendency to formation of a fistulous opening, and, also to contraction of the laryngofissure, two flaps from the adjoining muscles were thrown over and partly into the opening. The skin was loosely united with a few interrupted sutures.

The patient felt quite well at the end of the operation. The foot end of the bed was raised, and was kept raised for a week. Two days after the operation the intubation tube was coughed out and was not reinserted. For ten days part of the breathing was through the wound. After this the wound promptly improved in appearance.

Our patient left the hospital two weeks after the operation. The antiluetic treatment was to be kept up, but unfortunately this woman became reckless, left town and disappeared.

Though I have not had an opportunity to operate on a second case so far, I have tried out on the cadaver some modification which seems to be an improvement. In making the laryngofissure, the incision is curved in a manner as to cut out a long, rather narrow, strip in an oblique downward direction from one-half of the thyroid cartilage, though in continuity with the other. The direction and shape of the incision is best understood from the sketches (Figs 4 and 5). This piece of cartilage is then lifted over into the vertical gap of the lower portion of the laryngofissure and makes here a firm and

OPERATIVE RELIEF OF LARYNGOSTENOSIS

exactly fitting interposition. Where the notch at the upper border of the thyroid cartilage is deep, it is better to place the base of the wedge higher up, *i e*, at the notch itself. If the larynx is not severely stenosed and does not require any intralaryngeal operating, as for instance in asphyxia from paralysis of the posterior crico-arythenoid muscles, the mucosa need not be opened. The wound healing and post-operative course are then very simple. This so-called "posticus paralysis," which is a most unfortunate complication when it occurs after thyroidectomy, may thus be relieved by a comparatively simple operation, and the indefinitely prolonged wearing of a tracheotomy cannula can be avoided.

The method of widening the larynx in the manner described was so satisfactory and appeared so different from the straight up and down laryngofissure, that it changed it in reality into a laryngoplasty, and made it seem of sufficient practical value to be reported.

POST-OPERATIVE PULMONARY EMBOLISM*

By KELLOGG SPEED, M.D.

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THE unexpected and too frequently fatal occurrence of pulmonary embolism after operation still remains somewhat of a clinical mystery. Its study leads to many questions starting with the physiology and chemistry of the blood. It also involves mechanical factors and we may again consider a series of this unwished for post-operative complication.

From the records of the Presbyterian Hospital I have found thirty instances—seventeen men and thirteen women—in the past fourteen years. Probably there have been many more, certainly many more without fatal termination. All emboli following either simple or complicated labor cases have been omitted.

Type of Operation—The operations have varied. All have not been in the lower abdominal cavity. The enumeration has been as follows:

Herniorrhaphy—3 inguinal, 2 post-operative abdominal, 5 cases

Hysterectomy (fibroids)—4 cases

Cholecystectomy and post-operative hernia—1 case

Bone operation, neck of femur—1 case

Bone transplant in femur—1 case

Removal of fibroid from uterus—1 case

Appendectomy—1 case

Cystotomy (suprapubic)—3 cases, 2 first stage prostatectomies, 1 stone in bladder

Laminectomy—1 case—osteochondroma of the dorsal vertebrae

Paracentesis abdominis for carcinomatosis following carcinoma of the stomach—1 case

Prostatectomy—2 cases

Ectopic tubal rupture with abdominal hysterectomy—1 case

Pelvic abscess—1 case

Gastro-enterostomy (carcinoma of stomach)—1 case

Superficial operation for removal of necrotic tissue involving penis and scrotum after electrical burn—1 case

Varicose veins of leg—1 case

Insertion of radium in prostate—1 case

Pyelotomy (for stone)—1 case

Closing a colostomy—1 case

Thyroidectomy—1 case

The type of anaesthesia used was as follows:

Ethylene alone—4 cases—Closing colostomy, insertion of radium in prostate, operation on neck of femur, thyroidectomy

Ethylene—Ether—1 case—Hysterectomy

Gas Oxygen alone—no cases

Gas Oxygen Ether combined—14 cases—Pyelotomy, ventral hernia, hysterectomy—

* Read before the Western Surgical Association, October 14, 1926

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2 cases, post-operative hernia, removal of burned tissue, gastro-enterostomy, cystotomy—
2 cases, drain pelvic abscess, ectopic pregnancy and lipectomy, prostatectomy, removal
of fibroid, cholecystectomy and post-operative hernia

Novocaine intra-sacral—1 case (Prostatectomy)

Ether alone—8 cases—Herniotomy—2 cases, varicose veins, laminectomy, cystotomy,
appendectomy, hysterectomy, bone transplant—ununited fracture of femur

No anæsthesia given—1 case—Paracentesis abdominis

No anæsthesia mentioned on record—1 case—Hernia (probably ether)

Autopsy was made in twelve instances

The average ages of the men patients was 53.3 years, while that of the women was 44.1 years. This difference was influenced by the fact that operations on women are performed in earlier years for infection, fibroids, etc., many men present themselves late in life for prostatectomies.

The number of deaths was 23, a mortality of 77 per cent. The non-fatal cases were pyelotomy, ventral hernia, post-operative hernia, electric burns, gastro-enterostomy, cystotomy for stone and operation on neck of femur. A fear of death before and immediately during the embolism was manifested only by 4 patients as far as the records show.

The operative wound was infected in 12 of the patients. Sometimes this was manifested simply by redness, not by pus.

Post-operative fever, usually starting immediately after the operation, was present in all but 5 patients.

The presence of a leucocytosis, taking a count of over 7000 cells per cubic mm, was present in all but four instances.

The average time elapsing between operation and onset of symptoms in the 23 fatal cases was about seven days, the longest being twenty-five days, the shortest one day—of which latter interval there were four instances.

Thrombosis was noticed in 7 cases, once the patient herself called attention to it. This thrombosis occurred in the leg six times and the thigh once. In one instance it involved both legs—a non-fatal case, pyelotomy.

The symptoms of embolism first noticed were usually sharp pain in the chest, frequently referred to the midline and substernal or epigastric. In some instances the pains were lateral, as pleuritic pain. Cough, a rise in temperature and beginning chest findings followed in the average case, which survived a few days. The records show that only 11 patients gave positive chest findings. This is explained partly by the fact that many of the emboli were massive and death followed within a few minutes, not permitting chest examination. In other cases no chest examination was made and recorded.

The chest examinations in the patients well watched gave at first obscure information—there were no findings on percussion and very few on auscultation, pain alone dominating the field. At first in an average case which survived long enough to give an opportunity for chest examination, crackling râles would be heard—most frequently over the lower lobes, rarely on both sides. Then followed changes in vocal fremitus and in a few days dulness and pneumonic-like signs.

De Quervain says that three-fourths of all true post-operative deaths

after operations on the stomach are caused by lung complications—emboli, pneumonia and gangrene of the lung. Wharton and Pierson¹ consider that 50 per cent of the deaths following gynecological operations are caused by embolism alone. At St Mary's Hospital, Rochester, after 57,000 major operations the mortality from pulmonary embolism equalled 0.07 per cent. Cutler and Hunt² found 3.52 per cent post-operative pulmonary complications in 1562 cases—mostly emboli—and they express the further belief that 1 of every 28 patients operated upon for major surgical procedure will have pulmonary complications, while 1 in 142 will die from such complications. Weinbiter (*Zentralbl f Gynak*, vol LX, pp 1560-1566, July 11, 1925) after 13,000 gynecological operations found embolism in 0.5 per cent. Ochsner³ found at Augustana Hospital that pulmonary embolism accounted for

	Per cent
7 deaths in 16,696 operations	0.042
5 deaths in 5,275 laparotomies	0.1
1 death in 528 hysterectomies	0.5

The common physiologic facts of thrombosis are not here discussed in a clinical review of post-operative pulmonary embolism, but for the sake of mutual understanding, we may say that if certain elementary factors are absolutely necessary to produce intravascular thrombosis of blood, they may be

1 Thrombokinase derived from the body tissues—probably liberated by a wound trauma—finds its way *via* lymphatics or an open vein into the blood stream in small amounts

2 Venous stasis must be present in or near the great veins. Other factors as the presence of bacteria, toxins causing corpuscle disintegration and trauma aid these two principal ones

The first formed portion of a thrombus is pale, it contains an excessive proportion of platelets which become agglutinated into mural masses and eventually stick to the vessel wall. Some of the platelets break down to liberate thrombokinase and the mechanism of clotting has started, the resulting clot containing blood-cells and fibrin being dark in color. This clot may extend to the next anastomotic branch.

It has been shown (Sheen *Brit M J*, vol II p 950, November 22, 1924) that intravascular clotting does not follow intravenous injection of thrombin, when the blood is in a condition of circulation. Likewise an increase of the amount of calcium in the blood over the maximum requirement for clotting purposes may cause a reduction of clotting power.

Intravascular injections of commercial peptones and hirudin extract from the buccal cavity of the leech retard blood coagulation—but their use is not practical from a clinical standpoint.

¹ J A M A, vol LXIX, pp 1904-1910, December 2, 1922

² Arch Surg, vol I, pp 114-157, 1920

³ ANNALS OF SURGERY, vol LXII, p 91, 1920

POST-OPERATIVE PULMONARY EMBOLISM

From a pathological viewpoint, thrombi may be divided into two classes aseptic, which is friable and liable to become detached and assume embolic power only in the early stages of its development, septic thrombus, which is in a constant state of softening and disintegration and therefore may constantly give off embolic fragments and be a greater menace

The pathology may be reduced to simple terms depending on the size of the embolus, its septic or aseptic character and the size and position of the occluded artery

First Group—A large embolus with practical occlusion of the pulmonary artery on one or both sides cutting off blood from one or more lung lobes Pulmonary œdema follows, with death in all but a small percentage of cases

Second Group—Moderate-sized emboli which slip past the main artery opening and occlude smaller branches, resulting in pulmonary infarcts A hemorrhagic consolidation of the infarcted lung or lobe follows Pleurisy, gangrene, abscess or pneumonia may follow This type gives a mortality of 12 per cent to 15 per cent

Third Group—Small emboli—often unnoticed—nearly always undiagnosed Small infarcts in the lungs may follow but there are few physical findings in the chest, little fever, rare hæmoptysis and no deaths unless the infarct is septic and leads to empyema or lung abscess

The lung has blood supply from the bronchial arteries which may hold the tissue alive for a short time after complete plugging of the pulmonary If the patient survives a few hours, there is found congestion and œdema of the lung tissue proper from this source

The symptoms vary with the type of post-operative embolism Usually the sooner after operation the embolism occurs, the higher the mortality Massive embolism commonly occurs within a week after operation Pulmonary infarction, the second type, arrives in the second and third week post-operatively In massive embolism death usually follows within a few minutes Should the patient survive, the early chest examination reveals nothing, but within a few hours fine râles are heard A slight change of the percussion note follows, friction rubs may develop and later increased vocal fremitus and signs of consolidation may be made out This same course follows in varying degree in infarction Small infarcts may give no findings even to X-ray

In any clean post-operative case a low evening temperature is suspicious of thrombosis and significant of possible embolism to follow Some emboli supposedly from thrombi may be fat after fractures In his experimental work Dunn (*J Pathol and Bacteriol*, vol xxvii, p 425) found fat embolism in the lung of an experimental rabbit following unrecognized fracture of the body of a vertebra

In the matter of symptoms in non-fatal embolism one has to differentiate between myocardial degeneration and acute cardiac dilatation Precordial pain, dyspnoea and cyanosis may be the confusing findings, but in the well-examined surgical patient who has been studied before operation, the con-

dition of, and danger in the myocardium will be known and guarded against

Strains on the bed pan, efforts to rise from the bed, or to walk, or as in frequent post-partum accident when the woman turns over to assume a knee-chest position early in the puerperium, all give rise to sudden embolism. Whether this is sudden increase in blood-pressure or the result of suddenly increased pressure locally by surrounding tissues on thrombosed veins is not known.

Source of Emboli—The common source is not thrombus in the saphenous veins—easily recognized clinically and usually efficiently cared for. The unknown thrombus in the femoral or iliac veins is the common cause. In the jugulars or even the axillary thrombus may lead to embolism. In the five cases which happened to Gordon-Watson within one year (*Practitioner*, vol cvm, pp 381-393, June, 1922) one followed a breast amputation where axillary vein thrombosis was suspected, a second after cholecystectomy followed thrombosis of the superior vena cava and after a patella suture there was thrombosis of the internal iliac veins, all three cases being fatal from nine to sixteen days post-operatively. Two other instances, one after an appendectomy and one after thoracotomy for empyema, were not fatal. Massive thrombi must certainly come from the large iliac veins or their branches, as those in the broad ligaments.

In thrombosis of the saphenous vein de Quervain records (*Schweiz Med Wchschr*, vol lv, pp 497-505) an instance where a hernia operation was performed preceded by resection of both saphenous veins for varicosities. Sixteen days after operation the patient died of pulmonary embolism. One may well imagine that the thrombus in this case extended to the iliacs. After radium insertion in the pelvic organs—male or female—thrombosis may extend to the iliac veins by direct continuity as shown in our series. A similar case was reported by Frishmann (*Brit M J*, vol 1, p 212, January 31, 1925) of a woman of fifty-five years exposed to radium for the cure of epithelioma of the vulva, thrombosis of the iliac vein ensued, followed by pulmonary embolism. Four cases after operation on bones of children were reported by Fickenwuth (*Zentralbl f Chir*, vol lvi, pp 2821-2824, December 12, 1925). These were all fat emboli, not thrombic. After amputation of septic limbs two instances of embolism were reported by Fischer (*Beit z Klin Chir*, cxxiv, pp 222-229, 1921). These accidents might have been avoided by blocking the vein before taking off the dressings or manipulating the leg. It has long been the writer's practice when amputating the thigh for septic legs to perform a preliminary ligation of the main vessels before the leg is raised or manipulated in any way. Once in a while a femoral vein is found thrombosed up to Poupert's ligament. The application of a tourniquet to such legs may force clots into the venous circulation, expressed by the pressure of the constriction. Even the motions of preparation for amputation may free an embolus.

Pulmonary embolism has followed the injection of bismuth paste. Leb (*Beit z Klin Chir*, vol cxxviii, p 515) recorded an instance where the

POST-OPERATIVE PULMONARY EMBOLISM

paste was injected into a fistula remaining after an operation for goitre seven weeks before. The fistula was cuetted and 10 c.c. of a 30 per cent bismuth paste were injected. Cyanosis, shallow breathing and a small rapid pulse followed. An X-ray examination showed the bismuth scattered in the lungs. Pleurisy followed, eventually the bismuth shadows became absorbed. Against the possibility of lung emboli originating in the thrombus of the saphenous vein Magnus (*Klin Wchnsch*, vol. 11, p. 142, June 22, 1924) finds that the blood stream in this vein is centrifugal when the individual is in the upright position or walking. The peripheral part of the vein remains empty if the central portion is compressed. Lockhart-Mummery (*Brit M J*, vol. 11, pp. 850-857, November 8, 1924) had an instance of dislocation of the hip where the femoral vein was bruised and thrombosis in the iliac vein followed, leading to death from embolism.

Vietor (*ANNALS OF SURGERY*, vol. lxxxii, pp. 193-198, August, 1925) agrees that most thrombi originate in the femoral and pelvic veins. Many believe that a supine position retards circulation in the leg veins inasmuch as the femoral vein lies close under Poupait's ligament and the iliac veins are compressed by the arterial trunks. Amongst nine autopsies in the New York Hospital on patients dying of pulmonary embolism four had thrombi from the femoral veins, one from the common iliac, one from the inferior vena cava and only one case, carcinoma of the pancreas, had signs of existing phlebitis and thrombosis in the leg. Schilling reported that in 34 cases with a definite phlebitis diagnosed, only one died of pulmonary embolism. Judd and Scholl (*J A M A*, vol. lxxxii, p. 75, January 12, 1924) cite a case of malignant thrombosis of vena cava caused by the spread of a tumor of the kidney.

Our autopsy records show no known source of this thrombus in three cases, one from the right epigastric vein, two from the right iliac vein, one from the right saphenous vein, three from the left iliac vein, one from the vesico-prostatic flexus and left iliac vein, one from the superior vena cava. In one patient who suffered from carcinoma of the bladder, the right iliac and femoral veins were completely occluded and the thrombus extended up into the lower portion of the inferior vena cava. At the Adelaide Hospital, Cleland and Barlow (*M J Australia*, vol. 1, pp. 175-176, February 18, 1922) report that 25 per cent of all autopsies showed pulmonary embolism and in every instance the original clots were found in the leg veins.

In his *Surgical Pathology*, Boyd gives the sites from which emboli start as follows:

1. Veins, varicose of leg, inflamed pelvic and uterine, or those about an inflamed appendix.
2. Heart, thrombus formed in the right and left auricular appendix or vegetations on the mitral or aortic valves.

If as Hampton and Wharton believe (*Bull Johns Hopkins Hospital*, vol. xxvi, p. 35, April, 1920) the primary cause of thrombosis is infection and trauma while secondary causes are slowing of the blood stream, chemical

and physical changes in the blood and anatomical relations of blood-vessels, how can we explain embolism following perfectly clean abdominal or other operations? Possibly preexisting or accompanying hemorrhage, as the great blood loss from many patients with uterine fibroids prior to operation, may greatly strengthen the factor of blood change. There is no experimental proof known to the writer which verifies a decrease of coagulation tissue after prolonged hemorrhage.

Thrombus first means a margination and collection of blood plates with leucocytes and fibrin added within a few minutes, but just what causes endothelial changes in the blood-vessel sometimes remote from the operative field is not easily demonstrable. No operation, however, can be done without trauma—or the introduction of some organisms.

In Hampton and Wharton's series after operations on myoma uteri, 69 instances of thrombosis developed, 17 per cent were anæmic, 24 per cent had infections of the Fallopian tubes, and many had pelvic congestion with dilated veins and lymphatics. Only one of their patients had thrombosis prior to operation. They concluded that operation seemed to furnish the final condition necessary to thrombus formation. They found 205 instances of thrombosis: 66 per cent in vessels of the left leg, 24 per cent in vessels of the right leg, 9 per cent in vessels of both legs. Very rarely were vessels of the arm, superficial vein of the neck or mesenteric veins involved. The left femoral vein was involved in 40 per cent of cases. The left saphenous vein was involved in 12 per cent of cases. The left popliteal vein was involved in 2 per cent of cases. The pulmonary complications of thrombosis in 205 cases were: 70 per cent developed pulmonary infarcts and 15 per cent pulmonary emboli, that is, only three patients out of 205 showing clinical signs of thrombosis had pulmonary embolism, only one of which terminated fatally. Eighty-five per cent of their autopsy examinations after embolism showed the point of origin in the pelvic veins, usually after a symptomless course.

Femoral thrombosis clinically arrives in the second or third week post-operatively, hence its cause may be very different from pelvic thrombosis. It may also be noted that thrombosis of the pelvic veins without operation almost never causes embolism. In embolic accidents after pelvic thrombosis infection is rarely found and one must fall back on a traumatic theory of origin.

In their paper in 1920, Cutler and Hunt lay aside their early study of anæsthesia in relation to post-operative pulmonary complications and accepting embolism as the most important complication, describe the following etiologic factors: Sepsis, easy pathway to the lung and pleural cavity by blood-vessels and lymphatics, hypostasis from confinement to bed, which hypostasis is increased by unconscious (pain) splinting of the abdominal wall through partial inhibition of diaphragmatic movements. Any unexpected or additional movement which does occur, as in coughing, sneezing or deep sighing is liable to set free emboli in the operative field.

Henle (*Verhandl d Deutsch. Gesellsch f Chir*, vol xxx, p 240, 1901), Gottstein (*Arch f. Klin Chir*, vol lvii, p 409, 1893), and Mikulicz report a higher percentage of pulmonary complications with local anæsthesia than with general anæsthesia. Bevan (*Trans Am Surg Assoc*, vol xxix, p 177, 1911, vol xxxiii, p 21, 1915), Gatch (*Ibid*, vol xxix, p 196, 1911) and Herb (*J A M. A*, vol lxvi, p 1376, April 29, 1916) all believe ether is entirely satisfactory from the standpoint of post-operative pulmonary complications unless definite pre-operative pathology has existed in the lung. Since the advent of ethylene, pulmonary embolism still occurs.

Further statistics shed little light on the subject. Schilling found 32 cases in seventeen years—0.12 per cent of his operations—11 cases occurring after the use of local anæsthesia. Other reports are those of Wilson (*ANNALS OF SURGERY*, 1912, vol lvi, p 809), Wharton and Pierson (*J A M A*, vol cxxix, pp 1904-1910, December 2, 1922), Shaw (*Arch Surg*, vol ii, 535, May, 1921), Eisendreich (*Monatschr f Geburtsh u gynak*, vol liii, p 190, 1920) and Rupp (*Arch f Klin Chir*, vol cxv, p 672) who found emboli or infarcts in the lungs in 5 per cent of 12,971 cadavers examined in eighteen years. Twenty-two thousand six hundred and eighty-nine operative cases in eighteen years were followed by fatal thrombo-embolism in 0.26 per cent, while 1.1 per cent occurred amongst patients with medical diseases who died of this cause.

Treatment for this condition properly resolves itself into prophylaxis and active care in cases of embolism. Prophylaxis concerns

1 *The Patient Pre-operatively*—The patient should be put in the best possible physical condition and made the best physiologic risk possible under the circumstances. This includes a careful chest examination by an internist as a part of team work. Known foci of infection, as septic teeth, diseased tonsils or infected sinuses, should be eliminated. At the Presbyterian Hospital we use dental oral prophylaxis on all patients. Digitalis should be given if the pulse is small, the heart muscle weak or the systolic blood-pressure too low. Increase body fluids by blood or salt transfusion or glucose solution before, during and after operation. This is especially valuable in cases where large abdominal tumors are to be removed. Do not starve the patient before operation. Avoid operating on a patient with an existing lung lesion. Possibly morphia pre-operatively may be contra-indicated for its effect on slowing the blood stream.

2 *The Operative Technic*—Use no constrained position of the patient during operation—with pressure anywhere on the body during operation or in any position which promotes venous stasis, especially in the legs. It may be necessary to put a suitable mattress on the operating table, or to have the limbs held in the arms of assistants rather than by mechanical means (Trendelenburg position).

In operative technic reduce all trauma to a minimum using more sharp than blunt dissection. Employ no rough clamping or packing in of sponges. Harsh and prolonged retraction should not be used. Pressure by retractors

on small branches of the epigastric veins may start thrombosis. Remove all clots from the operative field. Do not use mass ligation. If wounds are septic, drain thoroughly to avoid spread of sepsis and absorption of its products. Avoid chilling of the patient by exposure to cold tables or packs, or widely gaping wounds at operation. Overstretching of the spinal column in gall-bladder operations is to be avoided.

3 *Post-operative Care*—Do not use anything which promotes venous stasis such as tight spicas to the hip with pressure on the femoral vein, or too tight heavy abdominal dressings and binder. Keep up the body fluids by means of salt solution, blood or glucose. Use digitals. Avoid strains in bed—as movements to change position or straining at stool or to change dressings. Oil or other enemata will help avoid strain. Do not stroke or rub thigh or abdomen. Give the patient frequent change of position. Systematic light exercises in bed are beneficial. Any new or unexpected pain in the abdomen or femoral regions should be noted at once and the patient should be requested to make report.

If thrombosis in the leg veins appears, should the vein be ligated? As far as statistics go, the results from frank thrombosis are not frequently fatal. Each case must be judged on its own merits. Probably if showers of emboli were occurring from a known thrombosis, one would be tempted to do a ligation to avoid massive embolism. Consider especially the patient of susceptible age or with lowered vitality.

Active treatment in known massive embolism is too frequently futile. Much depends on the clot size and the part of the pulmonary artery involved. Venesection to relieve the right heart aids. Rapid stimulants as camphor, ammonia, epinephrin or digitalis preparation should be given hypodermatically.

The Trendelenburg operation was advised by the originator because it was felt that often (50 per cent) only one branch of the pulmonary artery was occluded and removal of the thrombus promptly would revive the patient.

A horizontal incision 10 cm. in length is made over the second left rib, crossing the inner end of the incision by one perpendicular to it, starting just below the sterno-clavicular joint, passing downward to the third rib about one inch outside the left sternal border. The internal mammary artery is dodged—the second rib and its cartilage are cleared out of the way. The cartilage of the third rib is likewise removed and the pleura is opened, over an extent corresponding to the external incision. The pericardium then comes into view, it is opened by an incision inside the passage of the phrenic nerve at the level of the third rib.

By means of Trendelenburg's special sound a rubber tube is passed through the transverse sinus around the ascending aorta to the pulmonary artery. The pulmonary artery is then opened by an incision one-half inch long and the clot is pulled out by means of a special curved forcep. No more than forty-five seconds of time between opening the vessel under pressure

POST-OPERATIVE PULMONARY EMBOLISM

and removing the clot may be consumed—interruption of circulation longer leads to certain death

Kuschner (*Arch f Klin Chir*, vol cxxxiii, pp 312-359) at the Congress of German Surgical Society in Berlin in April, 1924, presented the first patient cured of pulmonary embolism by Trendelenburg's operation. The patient was a woman thirty years old, who had sustained a massive pulmonary embolism the third day after a femoral herniorrhaphy when she sat up in bed for a lung examination. Fifteen minutes later when she was moribund, the operation was begun. For forty-five seconds the large vessels were closed off during which time after exposure and opening of the pericardial sac the pulmonary artery was opened and blood clots which extended a distance of 17 cm were removed. Another case recovered after this operation in 1925, reported by Wermbter (*loc cit*), but died within a few days from an intercurrent disease.

Only a small amount of experimental work in this subject has been done and the very inviting field lies open. Krampf (*Deutsche Ztschr f Chir*, vol clxxxix, pp 216-240, 1924) gave his results after artificial blocking of branches of the pulmonary arteries by ligatures and by embolism and the effect on the collateral pulmonary circulation. Two other investigations are to be found, one by Binger, Biow and Bianchi (*J Clin Investigation*, vol 1, pp 155-180, December, 1924) on experimental studies on rapid breathing tachypnoea, dependent on anoxæmia resulting from multiple emboli in the larger branches of the pulmonary artery and in the same volume pages 127-153 on the subject independent of anoxæmia in pulmonary arterioles and capillaries.

POST-OPERATIVE MASSIVE COLLAPSE OF THE LUNG~

REPORT OF BRONCHOSCOPIC OBSERVATIONS

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RECENT important contributions have done much in directing the attention of surgeons and internists to Pasteur's original observations regarding massive collapse of the lungs and its occurrence as a post-operative complication

Numerous clinical and experimental studies have been carried out by many observers and various theories have been advanced to explain the etiology, but no one factor or group of factors seems to satisfactorily account for the production of the atelectasis Jackson, McCrae, Manges, Pancoast, Bowen and others have made many valuable observations in cases of atelectasis produced by foreign bodies in the bronchi These cases are the result of a stop-valve obstruction of a bronchus † and the condition can be considered as an obstructive atelectasis

Whether this mechanism can satisfactorily explain the cases of acute post-operative atelectasis has not been positively established, however, it has been definitely shown by Jackson and Lee † that in one case of massive collapse of the lung the condition was one of obstructive atelectasis This case was observed bronchoscopically by Dr Gabriel Tucker, who found mucous plugs obstructing a bronchus Bronchoscopic removal of these plugs was followed by a marked improvement in the aeration of the involved lung and a rapid recovery of the patient

The importance of this entire subject and the need for recording all observations made on these cases has led the writers to report their personal observations in the following case

The patient, a child, aged eight years, was admitted to the Surgical Service of Professor J Chalmers DaCosta, Jefferson Medical College Hospital, for closure of a gastrostomy fistula

Six years previously gastrostomy had been performed by Dr W P Hearn when the patient was admitted to the Bronchoscopic Clinic in a serious state of dehydration and starvation, the sequel of extensive lye burns and cicatricial stenosis of the œsophagus A functional cure had been obtained and now closure of the fistula, which had persisted following removal of the feeding tube, was decided upon

Preliminary physical examination of the heart and lungs revealed no abnormal findings

June 10 the gastrostomy fistula was closed by Doctor Hearn, under ether anæsthesia

* Read before the Philadelphia Academy of Surgery, October 4, 1926

† Jackson, Chevalier, and Lee, W Estell Acute Massive Collapse of the Lungs
Trans Am Surg Assoc, vol xliii, p 723, 1925

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administered by the open method. The anaesthetist reported that the patient took the anaesthetic poorly, there was an annoying, short, irritative cough and considerable trouble was experienced with secretions in the mouth and throat.

The post-operative recovery seemed uneventful. About thirty-six hours after operation the temperature gradually rose to 101° , the pulse rate was 130 per minute and the respiratory rate was 48. Examination of the chest by Dr Norman MacNeill revealed a few coarse râles over the left lower back and axilla. The following morning the temperature was 103.4° and the physical signs suggested a pneumonia involving the left lower lobe. Later examinations by Doctor MacNeill showed an increase in the chest signs and a diagnosis of massive collapse of the left lung was made. Dr E. H. Funk, who saw the patient in consultation, corroborated the physical findings and concurred in the diagnosis.

Physical Findings—Patient restless, moderate dyspnoea present. There is practically no cough. Respiratory rate, 50 per minute. Trachea displaced to the left of the median line. Chest flattened on the left side. There is practically no movement of the left chest with respiration. Percussion note dull over the entire left chest to left border of sternum. The entire right chest and the area corresponding to the sternum gave a hyperresonant note on percussion. Breath sounds were practically inaudible over the area of dullness. Apex impulse in 5 I S 8 centimetres to left of midline (practically in anterior axillary line). The cardiac impulse was very diffuse extending into the left axilla. The signs suggested collapse of the entire left lung with displacement of the heart and mediastinal structures to the left.

Röntgen-ray studies of the chest made by Dr W. F. Manges were reported as follows: "There is complete collapse of the entire left lung. The trachea and heart are drawn far to the left. It is impossible to see the outline of the heart or of the left diaphragm. The lung and heart shadows are of equal density so no detail can be seen in the left chest (Fig. 1).

Diagnostic bronchoscopy was decided upon and this was performed 72 hours after operation and about 8 hours after a diagnosis of massive pulmonary collapse was made. This was performed without anaesthesia, general or local. A large quantity of very thick, tenacious, yellow, odorless secretion was found in the trachea and left bronchus. Ten cubic centimetres of secretion were removed with a specimen collector. The mucosa of the left bronchus and its subdivisions was found very inflammatory. The right bronchus seemed normal and was free from secretion. When first observed, the lumen of the left bronchus was completely occluded by the secretion and no air was seen to enter the left lung. The bronchial walls did not move with respiratory movements. Following aspiration of the secretion, the bronchial lumen was seen to dilate and contract with inspiration and expiration.

Immediately after bronchoscopic aspiration, a striking change in the physical signs was observed. There was movement of the left chest with respiration, breath sounds could be heard over the entire left lung, many coarse râles were heard, the cardiac impulse was less diffuse and the apex beat was nearer its normal position. The patient's general condition seemed improved. The temperature remained practically unchanged, however, there was a perceptible decrease in the pulse and respiratory rates.

A Röntgen-ray examination of the chest was made one hour after bronchoscopy. Doctor Manges reported "that the left lung now contains a considerable quantity of air. The trachea is near the median line. The right border of the heart is even with the right border of the spine shadow and the outline of the diaphragm as well as the left border of the heart is clearly seen. There is evidence of lung function, as there is more air in the left lung at inspiration than at expiration. This definitely indicates that some obstruction was removed from the left main bronchus at the time of bronchoscopy" (Fig. 2).

In 18 hours there was a recurrence of all the signs of pulmonary collapse, as

shown by physical examination and radiographic studies (Fig 3) A second bronchoscopy was performed 44 hours after the first bronchoscopic aspiration of secretion

FIG 1 A

FIG 1 B



FIG 2

FIG 3

FIG 1 A —Rontgenogram made seventy-two hours after gastrostomy had been performed under general anaesthesia shows practically complete collapse of the entire left lung with displacement of the heart and trachea to the left side of the dorsal spine. The physical signs were typical of pulmonary atelectasis.

FIG 1 B —Rontgenogram, made thirty-six days after the onset of the pulmonary collapse reveals a normally aerated left lung. Physical examination revealed no abnormal findings and the patient seemed well. Bronchoscopic aspiration of thick secretion was performed seven times the last aspiration having been done thirteen days before this film was taken. (Film by Dr W F Manges.)

FIG 2 —Rontgenogram made one hour after the first bronchoscopic aspiration of ten centimetres of thick tenacious secretion revealed a striking contrast (see Fig 1 A). There is a considerable quantity of air in the left lung; the trachea is nearer the midline; the heart shadow can be clearly outlined and has returned toward its normal position and the left diaphragm can be clearly seen. By fluoroscopy function of the left diaphragm was observed and a change in the air content of the left lung was noted during inspiration and expiration. There was no evidence of paralysis of the diaphragm.

FIG 3 —Rontgenogram made eighteen hours after the first bronchoscopic aspiration of secretion shows a return of the lung collapse not unlike that observed originally in Fig 1 A. (Films by Dr W F Manges.)

The findings were practically identical with those originally observed except that 14 cubic centimetres of thick secretion were removed with the aspirator. Bronchial movements were again observed following removal of the obstructing mucus and air seemed

POST-OPERATIVE MASSIVE COLLAPSE OF THE LUNG

to freely enter the left lung. This was corroborated by the findings on physical examination.

On the following day there was marked improvement in the patient's general condition, the temperature was 100° and the pulse and respiratory rates showed a marked

FIG 4 A

FIG 4 B

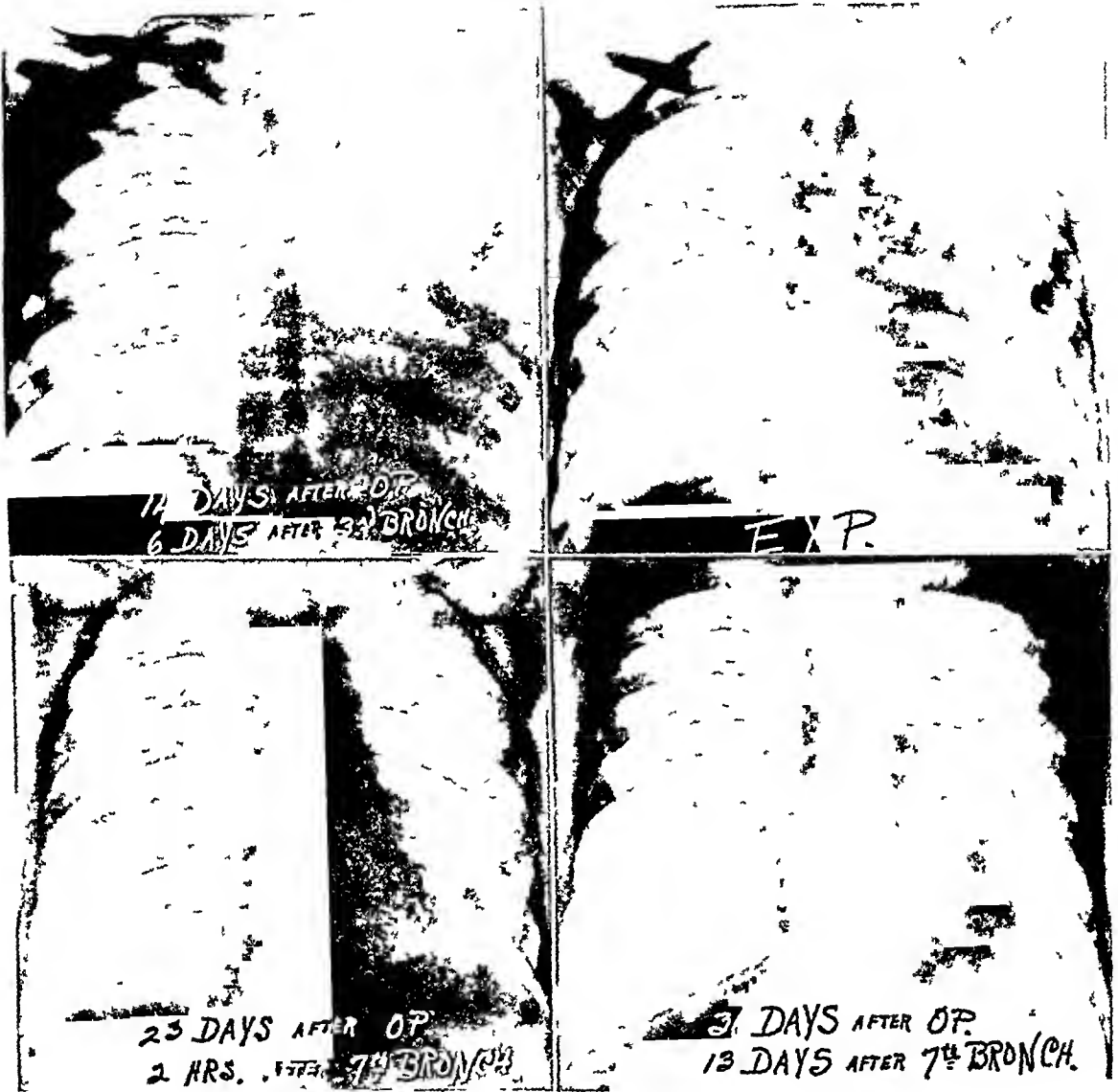


FIG 5 A

FIG 5 B

FIG 4 A—Rontgenogram made on the fourteenth day after operation and six days after the third bronchoscopic aspiration shows increased aeration of the left upper lobe with a persistence of collapse of the left lower lobe.

FIG 4 B—Rontgenogram made on the fifteenth day after operation one and one-half hours after the fourth bronchoscopy shows striking changes when compared with FIG 4 A. There is now better aeration of the entire left lung especially the left lower lobe. The heart and left diaphragm are well outlined and diaphragm function can be observed fluoroscopically. (Films by Dr J T Farrell Jr.)

FIG 5 A—Radiogram made two hours after the seventh and last bronchoscopy on the twenty-third day after gastrectomy. There remains some cloudiness of the left lung field, the heart and mediastinum are practically in their normal position. The left diaphragm is about normal in position and function. At the seventh bronchoscopy, but three cubic centimetres of thick secretion were aspirated from the left lower lobe bronchus, the left upper lobe bronchus appeared normal.

FIG 5 B—Radiogram made thirteen days after FIG 5 A reveals a practically normal appearing chest. Both lungs are clear, the heart is in normal position, both diaphragms function normally. (Films by Dr J T Farrell Jr.)

decrease, however, the physical signs and Rontgen-ray studies indicated a recurrence of the collapse. Later in the day (sixth day after operation) the temperature rose to 104.2° without any change being observed in the chest findings.

On the eighth day after operation the patient's condition was good, the temperature

being 100.2° , however, there seemed to be an increase in the pulmonary collapse. A third bronchoscopy was done and but $4\frac{1}{2}$ cubic centimetres of secretion were obtained. The endobronchial appearances showed no change over those of previous examinations. There was no increase in the activity of the cough reflex.

Striking improvement in the general appearance of the patient was observed following this bronchoscopy (eighth day after operation), so further aspiration was deferred, however, the physical signs and radiographic findings indicated a recurrence of the collapse. The fever slowly subsided and reached normal on the thirteenth day after operation, but rose the next day to 100° . The physical signs indicated that a very small quan-

tity of air was entering the left upper lobe, the left lower lobe seemed airless. Cough was becoming more active, but seemed to be inadequate to expel the secretion. Bronchoscopy was again done on the fifteenth day after operation. The removal of 4 c.c. of secretion was followed by improvement in the physical signs and Röntgen-ray findings (Fig 4, A and B).

With the striking changes observed immediately following bronchoscopy and recurrence of the collapse within one or two days, it was decided that more frequent bronchoscopic aspiration be resorted to. These were carried out on the seventeenth, the nineteenth, and the twenty-third day after operation. The quantity of secretion removed was $4\frac{1}{2}$, 4 and 3 cubic centimetres, respectively. The secretion became progressively less tenacious and at the two last aspirations it was found



FIG 6—Radiogram made in the case of a child aged three years eight hours after the accidental aspiration of a portion of pencil with metal cap attached. There was marked atelectasis of the left lung with displacement of the trachea, heart and mediastinal structures to the left. These Röntgen-ray findings were corroborated by physical examination. The foreign body was removed bronchoscopically about nine hours after the accident. A radiogram made twenty hours after removal of the pencil revealed a normally functioning left lung and the mediastinal structures in normal position. (Films by Dr Leon Solis Cohen.)

only in the lower lobe bronchus, none coming from the upper lobe. The physical signs showed a return of almost complete lung function. The heart remained displaced to the left. The temperature returned to normal. The cough reflex became more active and for the first time the patient was able to cough up and expectorate secretion from the tracheo-bronchial tree.

A Röntgen-ray study of the chest made two hours after the seventh and last bronchoscopic aspiration was reported by Dr J. T. Farrell to show that the left lung contained more air than at any time since the onset of the collapse (Fig 5), and that the exudate had almost completely disappeared. The heart remained slightly displaced to the left side.

Convalescence was uninterrupted and the patient was discharged well July 28, forty-eight days after operation. Physical examination of the chest revealed no abnormal findings. Radiographic examination showed a perfectly aerated left lung. The peribronchial shadows seemed heavier than normal. The heart was in normal position.

POST-OPERATIVE MASSIVE COLLAPSE OF THE LUNG

Blood Studies—Examination of the blood was carried out by Dr I C Lintgen. This revealed a moderate leucocytosis which never exceeded 12,000.

Studies of Bronchial Secretion—Examination of the bronchial secretion was carried out by Dr B L Crawford. The secretion was removed bronchoscopically with the aid of a Lukens' specimen collector and the entire quantity was submitted to the laboratory. It was so thick and tenacious that it remained adherent to the bottom of the collector when this tube was inverted (inside diameter of tube is 2 cm). Direct smears of the material revealed many pus cells, a large amount of mucus and fibrin and many Gram-positive diplococci. Cultures showed a pneumococcus with an occasional staphylococcus aureus. Subsequent specimen showed the pneumococcus in pure culture.

Comment—Several factors in this case must be carefully considered in arriving at conclusions regarding the etiology.

It is important to recall, that patients with a stenosis of the œsophagus, sufficient to interfere with the free passage of food and fluid into the stomach, often aspirate material into the air passages and an associated chronic laryngo-tracheobronchitis is a not uncommon finding. Especially is this true in the case of children with œsophageal stenosis. Furthermore, frequent œsophageal manipulations tend to establish tolerance to pharyngeal and probably to laryngeal stimuli. This patient took the anæsthetic poorly and a large quantity of secretion was present in the mouth and throat.

Irrespective of the factors which caused the production of the tenacious secretion and interfered with its expulsion, this secretion undoubtedly produced the pulmonary atelectasis. Bronchoscopy revealed bronchial obstruction with absence of lung function. After removal of the obstruction there was a return of the bronchial movements, and, by physical examination, fluoroscopic observation and radiographic studies, it was conclusively shown that air again entered the lung tissue, the diaphragm resumed its function and the lung expanded. With the recurrence of the bronchial obstruction the lung again collapsed only to resume its function when the obstruction was removed. This observation was made seven times in one case and is supported by evidence secured by physical examination, by Röntgen-ray studies and bronchoscopy.

The bacteriological findings seem to present nothing unusual, however, the physical characteristics of the secretion are of importance. The thick tenacious mucus found in this case was not unlike that observed in several patients presenting asthmatoïd symptoms. In these patients the hicc reflex was very active but cough was unproductive. Complete temporary relief was obtained only by bronchoscopic aspiration. This would tend to support the theory that altered secretion of the bronchial epithelium may be an etiological factor.

Collapse of a lung does not immediately occur following complete plugging of a bronchus. Recurrence of all the signs of complete collapse occurred within about twenty-four hours in this case. That collapse does occur quite rapidly was shown in a recent case observed at the Bronchoscopic Clinic. A child, aged three years, choked on a piece of pencil. The patient was observed röntgenologically eight hours after the time of the accident.

Doctor Manges reported the presence of a pencil cap and portion of pencil in the left main bronchus which completely obstructed the bronchus (Fig 6). There was marked atelectasis of the left lung with but a small quantity of air remaining. The heart was completely displaced into the left chest. A Rontgen-ray examination made twenty hours after the removal of the obstruction revealed the heart in its usual position and the left lung functioning normally.

CONCLUSIONS

Ultimate conclusions cannot be arrived at on the basis of observations made in one case, however, on the observations made in this case it can be stated:

That bronchial obstruction was present, in this case, that the obstruction consisted of thick, tenacious secretion.

That, bronchoscopic removal of the obstruction was followed by a partial return of pulmonary function, and further,

That early bronchoscopic investigation should be carried out in a case of post-operative pulmonary collapse if the surgeon and the internist deem it a safe procedure in the particular case.

MASSIVE HYPERTROPHY OF THE BREASTS*

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IN 1891, Dr C B Porter,¹ preliminary to reporting a case of massive hypertrophy of the breasts before the American Surgical Association, said, "I should not think of asking the attention of such a distinguished gathering of surgeons to the report of a single case, were it not that it falls to the lot of but few surgeons to see such a case and still fewer to operate on one." It is, indeed, still rare that the surgeon is asked to amputate the breast solely because it has attained such size, that it is a real burden to the patient, wearying her with its weight, and preventing her from carrying on her usual duties.

Massively hypertrophied breasts are of two types (1) The fibro-epithelial, and (2) the adipose type. The enlarged breast of the first type consists of fibrous tissue and glandular acini, usually with great preponderance of the former. That of the second type consists mainly of fat with some connective tissue dividing the fat into lobules and containing some atrophied glandular acini.

Of the less than one hundred authentic reports of massive hypertrophy of the breasts, only six† state that the main constituent of the enlarged breast was fat. The rarity of the reports of this form of massive breast-hypertrophy warrants a description of this case.

CASE REPORT.—History. M R, twenty years of age, colored, entered St Luke's Hospital, on the service of Dr S C Plummer on March 29, 1926, because of the enormous size of her breasts and the resulting inability to work.

She was always considered as fat, and her breasts were somewhat larger than those of other girls of her age. When fourteen years old, she weighed 148 pounds. At seventeen years of age her menstrual periods began. Soon her breasts began to grow very rapidly, all out of proportion to the rest of her body. She became generally more obese, but the breast-growth continued entirely out of proportion to her obesity. At nineteen she weighed 188 pounds and at entrance to the hospital 240. The breasts were so heavy that for seven months she could do no work and was forced to live on her meagre savings. The sagging of the breasts and friction of her clothes had caused superficial excoriations of the skin of the right breast.

She had a good appetite, ate an unrestricted diet twice daily, felt strong, had no digestive troubles, and slept much. She had dyspnoea when climbing stairs. This was relieved considerably by supporting the breasts with her hands to lessen the dragging on the chest-wall.

Her menstrual periods began at seventeen years of age, appeared regularly every

* Read before the Western Surgical Association, October 14, 1926.

† Guibrie and Albert,² Robert and Amusat,³ Warren,⁴ Beatson,⁵ and Keyser.⁶

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twenty-eight days, and continued for three to five days. Several of the last periods were only of two days' duration.

No other member of her family was obese. Her father, however, was 'somewhat stout'.

Physical Examination—The patient is an obese negress, about twenty years of age with enormous breasts (Fig 1). They both have about the circumference of an ordinary football, hang to a level of more than an inch below the umbilicus, have flattened nipples, and contain no definite nodules or hard masses. There are two superficial irregular ulcers, close to each other and about 3 cm in diameter, on the front surface of the right breast. The skin about the ulcers is darker brown than elsewhere. There

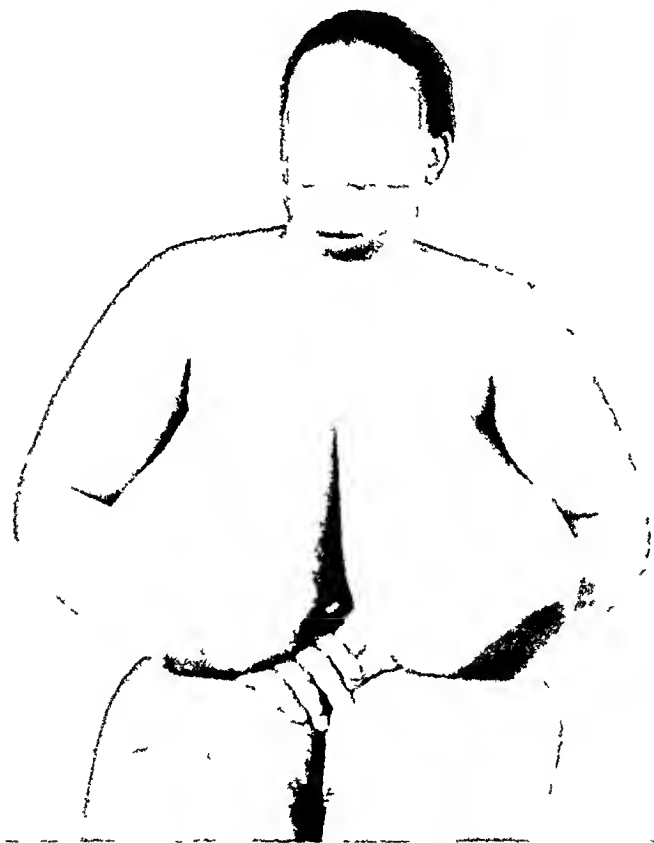


FIG 1—Massive hypertrophy of the breasts, photograph of case reported by Plummer

is a very light brown scar of the right breast, in all about 2 cm square, which resembles the scar from a burn. No other noteworthy deviations from the normal are found upon physical examination.

The basal metabolic rate is 65 per cent below normal. The blood Wassermann reaction is negative. There are 4,350,000 erythrocytes per cubic mm of blood, and 8950 leucocytes. The haemoglobin percentage is 85. The urine contains some albumin, numerous erythrocytes and bacteria, and many leucocytes. The systolic blood pressure is 130, the diastolic 84. The pulse rate is 80, the respiratory rate 24.

Operation—The breasts were amputated (Plummer) on April 3, 1926, by horizontal, elliptical incisions, leaving two horizontal suture lines. Ether anaesthesia was

used. There was very little hemorrhage and no post-operative shock. The left breast, immediately after amputation, weighed 9 pounds and 2 ounces, the right 9 pounds.

The patient's recovery was rapid and with primary healing of the wound. She was discharged April 15, 1926. Her next menstrual period was very scanty.

Pathological report by Dr Edwin Hirsch—These two female breasts are about equal in size and weight 9 and 9½ pounds. About three-quarters to four-fifths of the outside is covered with a dark brown skin, and in front is a nipple scarcely elevated 2 cm in diameter, with an areola 11 cm in diameter. In the skin of one, 10 cm from the nipple, are two superficial ulcerations 2.5 cm in diameter. There is no muscle tissue on the under surface of either breast. On surfaces, made by cutting, practically the entire substance is fat. The amount of fibrous tissue on these surfaces is estimated by three people to be 5 to 10 per cent.

On microscopic sections, portions of the breast contain small ducts and acini, distributed in fibrous tissue septa. Otherwise, there is only fatty areolar tissue.

MASSIVE HYPERTROPHY OF THE BREASTS

Discussion —Deaver and McFarland's ⁷ monograph on the breast contains 240 references to literature on hypertrophy of the breast. This is not a collection of 240 cases, as some have stated for, as Grieg ⁸ says, 51 of these articles contain no new case-reports, and another considerable number probably describes breast-enlargements due to tumors.

Grieg, ⁸ in 1922, could verify only 26 cases of true massive hypertrophy of the breast. The addition of 20 unverified, but probably authentic cases from Deaver and McFarland's list, and the one, reported by him, brought his total to 47.

Thirty-four of these were virgins, five were of doubtful chastity, six were women pregnant for the first time, and two were pregnant multiparous women. The ages of the virgins were eleven to twenty-three years, with nineteen as an average. The average age of those of doubtful chastity was twenty-four, of the primiparous pregnant women, twenty-six, and of the multiparous women, thirty-six. These figures concern mainly the fibro-epithelial type of breast-hypertrophy, for the case of Robert and Amusat ⁸ was the only adipose type included.

It is evident from the above statistics that hypertrophy of the breast at least that of the fibro-epithelial type, is associated with puberty and with pregnancy, hence, the terms vaginal, puberty, puberal, adolescence, gravidity, lactation, and puerperal hypertrophies have been used. Grieg ⁸ suggests that "puberal hypertrophy" be used to cover the group and includes the rarer variety, appearing with pregnancy, under this term.

When the hypertrophy of the breasts is first apparent, it is thought to be only the development which is normal for puberty or pregnancy, as the case may be. The enlargement, however, is progressive and soon passes physiological limits. The patient and her family are mortified by the great size of the breasts. The awkwardness, brought on by the size of the breasts, and the great weight with the dragging on the chest wall and embarrassment of respiration may quite incapacitate the patient.

The largest breasts were described by Durston ⁹ in 1669. They were said to have grown to their maximum size over night, following a cessation of menstruation for six months. The left breast weighed 64 pounds and the right 40. This case is probably authentic, except for the period of growth. The spirit of exaggeration on the patient's part, in order to make hers a remarkable case, probably accounts for the statements concerning the sudden appearance of the hypertrophy. Porter ¹ described two breasts, which were amputated by him, as weighing 43 and 17 pounds.

Disorders of menstruation, particularly very scanty menstruation and amenorrhoea, according to Grieg ⁸ and others, often are coincident with overgrowth of the breast.

Hypertrophied breasts may be of normal consistency. However, observers have not infrequently described the breasts as soft, except for many fairly distinct nodules throughout. When this nodular character can

be made out, one can feel fairly sure that the hypertrophy is not of the adipose type

Grieg⁸ states that "puberal hypertrophy" is a distinct condition. He does not think that huge, fatty breasts should be included in this category, because general obesity may be accompanied by larger than normal breasts, especially in men. The following table is made with data from the reported cases of adipose hypertrophy of the breast, including the case reported here.

TABLE I

Reporter	Year reported	Age	Menstrual	Puberty	Primipara	Multipara	Wt of patient	Pain	Growth period	Size of Breast	
										R	L
Robert and Amusat ³	1851	18	Amenorrhoea	×				+	1 yr	80 cm circum	80 cm circum
Warren ⁴	1905	43				2 abortions		0			
Beatson ⁵	1908	30	Amenorrhoea				196	+	6 yrs		
Guthrie and Albert ²	1911	24	Irreg absent for 3 mos		×		164	+	7 mos	5¼ lbs	4¾ lbs
Keyser I ⁶	1921	19	Scanty	×			178	0	5 yrs	4 4 lbs	4 95
Keyser II ⁶	1921	41	Normal			×	166	0	1 yr	5 02	4 07
Author's	1926	20	Late establishment scanty	×			240	0	2 yrs	9	9½
Average		28.8		3	1	2	188.8		2.6 yrs	5.9	5.72

It is evident from the data of this table that the essentials of the histories of these cases are much like those in which the breasts consisted mainly of fibro-epithelial tissue. The average age for the unmarried patients is nineteen, the same as that for the virgins of Grieg's collection. The age of the woman, pregnant for the first time, is twenty-four, while Grieg's average is twenty-six. The ages of the two multiparous pregnant women averaged forty-two. Grieg's average is thirty-six.

In five of the six reports of the table, which mentioned the menstrual function, a distinct departure from normal menstruation was described, with the tendency towards amenorrhoea. This also is in agreement with the statement of Grieg concerning the fibro-epithelial type.

The breasts of obese women may be singularly small, or they may be large, quite in proportion to the obesity of the body as a whole. The massively hypertrophied breasts of the adipose type not only develop at times and under conditions quite analogous to the fibro-epithelial type, but also have a structure which is not that of the breast of obesity. Guthrie and Albert² pointed out that the large breasts of general obesity, although con-

MASSIVE HYPERTROPHY OF THE BREASTS

taining large amounts of fat, have a real glandular portion, well circumscribed and quite free from fat, while the hypertrophic breast of the adipose type has the glandular portion disseminated in the connective tissue which divides the fat into lobules

Huge hypertrophy of the breast, occurring at puberty or pregnancy with a not infrequent menstrual abnormality, suggests that some constitutional disturbance, possibly of endocrine nature, is the inciting factor. Williams¹⁰ states that the normal increase of the female breast at puberty may often be due "even more to the overgrowth of its fibro-fatty envelope than to the glandular ectasia." It seems plausible that a constitutional or endocrine derangement, which causes great hypertrophy of the mammary fibro-epithelial tissue in the average non-obese young woman, may cause a marked hypertrophy of the fatty areolar tissue in individuals who are prone to deposit fat. The two types of hypertrophy have an important point in common. In both the hypertrophy is diffuse with dissemination of the acini. The main difference between the fibro-epithelial and adipose varieties is that in the former the tissue is usually mostly fibrous and in the latter mostly fat with a meshwork of fibrous tissue.

Inasmuch as these two forms of breast-hypertrophy cause truly massive breasts, and inasmuch as they, after all, are probably not so distinctly related, it seems logical that the term, massive hypertrophy of the breast, be applied as a descriptive term to include hypertrophies of both types, as was suggested by Keyser.⁶

Grieg⁵ accepted only eight cases of enlargement of the breasts accompanying pregnancy as belonging to this group. Von Angeles¹¹ says that the large breasts of pregnancy and those of puberty are differentiated by their course. The former are greatly reduced by abortion, confinement and by medical treatment. The latter do not respond to these measures.

It is noteworthy that most of the various reports of spontaneous resolution, or of resolution following the administration of iodides and tight bandaging, concern the enlargement of the breasts with pregnancy. Monod¹² saw a patient whose breasts became very large with each of three pregnancies, but returned to normal size after each confinement. Rosinski¹³ tells of a twenty-eight-year-old woman who was at the sixth month of pregnancy and had colossal breasts. With each of three preceding pregnancies there was great enlargement with ultimate resolution. Esterle¹⁴ states that the huge breasts of a pregnant girl of twenty years diminished to normal size after confinement and copious secretion of milk. One wonders if these were truly cases of the massive hypertrophy under discussion, especially since the latter are rarely reported as functioning breasts.

The report of spontaneous resolution of hypertrophied breasts by Benoit and Monteils¹⁵ illustrates the lack of function of these breasts and the time necessary for resolution. The breasts of their patient began to enlarge when she was fourteen and a half years old and continued to grow until she was eighteen. They remained about the same size for eight years and then after

the birth of three children, atrophied until the skin hung in loose folds. No milk was secreted at any time.

The treatment of massive hypertrophy of the breasts is apparent from the foregoing statements. The term, massive hypertrophy of the breasts, entails huge breasts, frequently of such size that invalidism is the patient's lot. When this enormous growth occurs at puberty, without the influence of pregnancy, amputation is the only treatment. The importance of the organs to be removed is no contra-indication to amputation, for seldom do these breasts functionate.

When pregnancy is seemingly the factor inciting the enlargement of the breasts, it is best to wait and watch. It is most difficult or impossible to distinguish the excessive physiologic-like growth of the breasts in pregnancy from the hypertrophied breasts, similar to those of puberty. The former, usually become normal or much reduced in size after parturition.

Fitzwilliams¹⁶ and Rovsing¹⁷ tried X-ray therapy without marked success. One of the breasts of Rovsing's patient, however, did decrease in size.

SUMMARY

A case of massive hypertrophy of the breasts of the adipose type is described. It is logical that this type be included with the fibro-epithelial type under the term massive hypertrophy of the breasts.

This affection, occurring at puberty, warrants amputation. When it occurs with pregnancy, operation should be delayed until it is evident that resolution does not follow the termination of pregnancy.

BIBLIOGRAPHY

- ¹ Porter, C. B. *Trans. Am. Surg. Assn.*, vol. ix, p. 367, 1891.
- ² Guthrie and Albert. *Journ. Am. Med. Assn.*, vol. lvii, p. 1583, 1911.
- ³ Robert and Amusat. *L'union Méd.*, vol. v, p. 219, 1851.
- ⁴ Warren, J. C. *Journ. Am. Med. Assn.*, vol. xlv, p. 149, 1905.
- ⁵ Beatson. *Edinburgh Med. Journ.*, vol. i, p. 524, 1908.
- ⁶ Keyser. *Surg., Gynecol. and Obst.*, vol. xxviii, p. 607, 1921.
- ⁷ Deaver, J. B., and McFarland, Jos. *The Breast, its Anomalies, its Diseases and their Treatment*. P. Blakistons, Son and Co., Philadelphia, 1917, p. 102.
- ⁸ Grieg, D. *Edinburgh Med. Journ.*, vol. xxviii, p. 153, 1922.
- ⁹ Durston, W. *Philosoph. Trans. Roy. Soc., London*, vol. iv, p. 1047, 1669, also cited by Kirchheim, *Arch. f. klin. Chir.*, vol. lxxviii, p. 582, 1902.
- ¹⁰ Williams, W. R. *Diseases of the Breast*, London, 1894, p. 11.
- ¹¹ Von Angerer, O. *Handb. d. praktische, Chir.* Bruns, Garre u. Kuttner, vol. ii, p. 604, 1919.
- ¹² Monod. *Gaz. d. Hop.*, vol. liv, p. 74, 1881.
- ¹³ Rosinski. Quoted by Deaver and McFarland.
- ¹⁴ Esterle. *Ann. Univers. di Med. Milano*, vol. clxii, p. 153, 1857, also *Gaz. Med. de Paris*, 1858, p. 678.
- ¹⁵ Benoit and Monteils. *Montpellier Med.*, vol. xxxviii, p. 481, 1877, also (abst.) *Cent. tralbl. f. Chir.*, vol. v, p. 30, 1878.
- ¹⁶ Fitzwilliams, D. *Lancet*, vol. ii, p. 218, 1923.
- ¹⁷ Rovsing. *Hospitaltidende*, vol. lxii, p. 577, 1919.

CONGENITAL HYPERTROPHIC PYLORIC STENOSIS

A STUDY BASED ON 48 PERSONAL CASES

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THE pylorus of the normal infant is a soft, pliable structure, the gastric and duodenal extremities being readily approximated by compression between the thumb and index finger. The pyloric circular muscle up to three months of age measures not more than 2.5 mm (Fig 1)

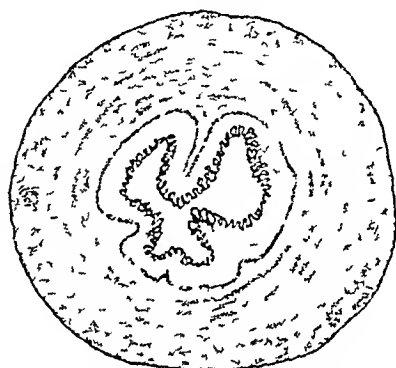


FIG 1 —Cross-section of normal pylorus magnified five times

In congenital hypertrophic pyloric stenosis (Fig 2) the pyloric region is occupied by a sharply defined tumor mass of unknown etiology, measuring from seven-eighths to an inch and a quarter in length and from five-eighths to six-eighths of an inch in diameter. It is of a firm, nearly cartilaginous consistency, covered with smooth, glistening peritoneum free from adhesions and having a whitish, pale color as compared with the remaining portions of the stomach and duodenum. Pathologically this tumor consists of a massive hypertrophy of the circular musculature of the pylorus, the hypertrophied circular muscle measuring from 3 to 7 mm in thickness up to three months of age. As a result of this tumor formation the pyloric canal becomes stenosed and greatly lengthened, constituting a mechanical interference and obstruction to the outlet of the stomach. The lesion has been observed in a seven months' foetus, and on a number of occasions in the still-born, and would, therefore, seem to be developmental, thus justifying the term "congenital." In a few instances, the condition has been observed in twins.

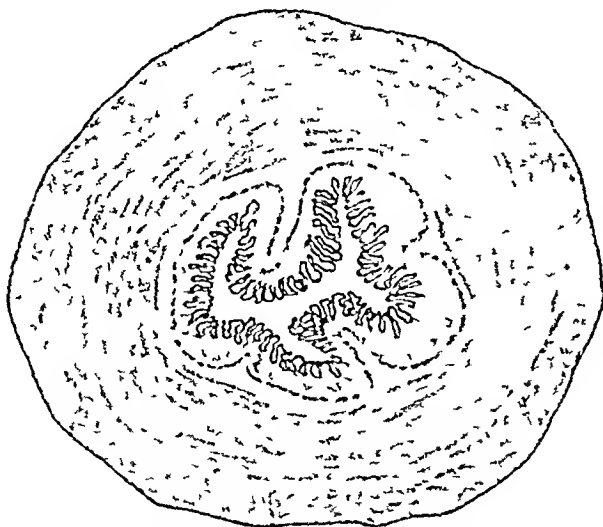


FIG 2 —Cross section of pylorus in case of hypertrophied pyloric stenosis, magnified five times

Gastric dilatation with atony and gastritis develop secondary to the obstruction in the neglected cases. In the presence of these pathological

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findings a striking clinical picture is presented, of explosive, projectile vomiting after each meal accompanied by isoperistaltic waves. As a result of the obstruction and vomiting the stools become absent or meconium-like, consisting of bile and mucus, the urine becomes scanty, dehydration and acidosis develop and there is a rapid, progressive loss of weight. These little patients shrivel up and the skin becomes dry and inelastic. Palpation of the abdomen is usually negative. Increase of tonic or clonic spasm of the abdominal musculature is absent. I have

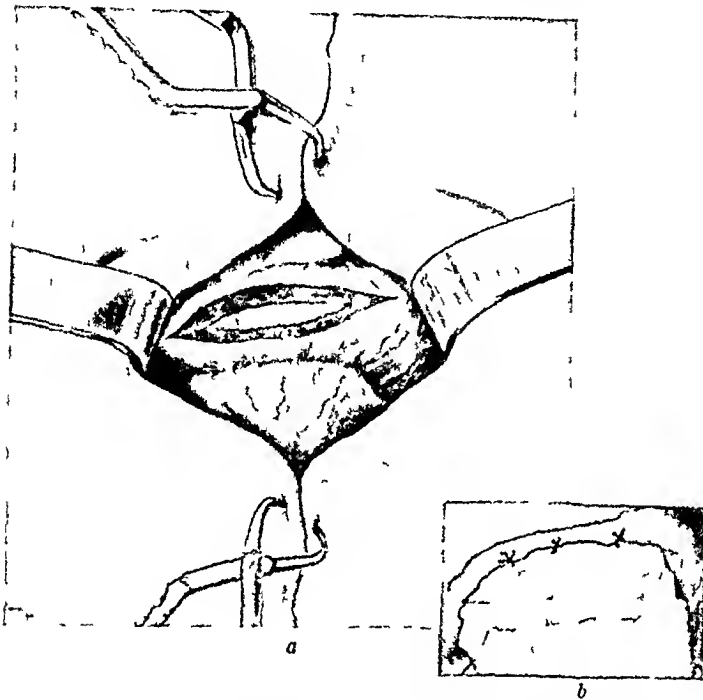


FIG. 3.—Rammstedt Operation. Illustration a showing longitudinal incision through the pyloric tumor mass. The hypertrophied circular muscles have been divided and spread showing the liberated mucosa of the pyloric canal below. Illustration b. Omental flap sutured over the Rammstedt incision to prevent objectional adhesions to the liver or other nearby structures.

been unable to palpate the tumor mass, and when it is recalled that the liver of the normal infant occupies two-fifths of the abdominal cavity, quite completely covering the stomach, we can readily understand why the tumor is not felt. This in spite of the common statement to the contrary, recalling the time when the chronically inflamed appendix was reported as being frequently palpated. Even with the abdomen open the pyloric tumor is only palpable by hooking the finger up under the liver.

The Röntgen-ray examination has not been found helpful nor necessary, the clinical picture being so clear and reliable. In fact, the Röntgen-ray study may be misleading in that the metallic, opaque substance used may pass quite readily through a pylorus which obstructs the passage of food.

The condition occurs most frequently in the male, there being only two female infants in the series of 48 cases. The majority were seemingly normal, well-developed infants at birth and were breast-fed, the symptoms beginning at the end of the second week and becoming alarming about the third week. Cases were referred to the pediatrician most frequently about the fourth or fifth week. Usually a week is spent under pediatric management, after which time, with continuance of symptoms, weight loss or no gain, the child is prepared for operation.

These cases are never so emergent as to require immediate operation.

Adequate pre-operative preparation is absolutely essential to success, and the more advanced and neglected the case the more important becomes the

CONGENITAL HYPERTROPHIC PYLORIC STENOSIS

need of this preparation. At least from twelve to twenty-four hours is well spent in overcoming the dehydration and acidosis. Gastric lavage should be done, continuance of feeding efforts, and, most important, water should be given under the skin and per rectum. Intraperitoneal injection has been tried, and while no ill effects followed, I consider the intraperitoneal reaction, as evidenced by turbid, flaky fluid, to be undesirable.

There is no field of surgical endeavor in which intimate cooperation between the physician and the surgeon is more imperative than in the surgery of infancy. The success achieved in this series of cases has been in a large measure due to the sharing of the responsibility for the patient while in the operating room and to the skilful pre-operative and post-operative care by the pediatrician.

Various types of operations have been practiced in the surgical treatment of this condition, including pyloroplasty and pylorotomy, with resulting prohibitive mortality. Devulsion of the pylorus by the introduction of dilators

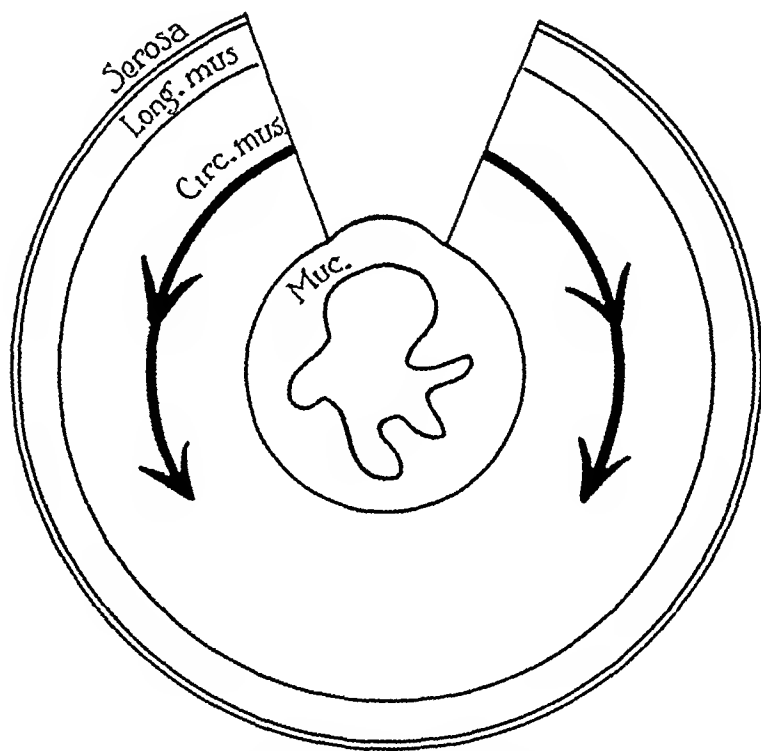


FIG. 4.—Diagram illustrating division of pyloric circular muscles, as in cutting of a ring, leaving the muscles without origin or insertion. The circular muscles retract and undergo disuse atrophy with permanent disappearance of the pyloric tumor mass.

through a gastrotomy, while not so dangerous, does not, in the majority of cases, give the desired relief. Gastro-enterostomy, both anterior and posterior, while giving a satisfactory result in the successful cases, is technically extremely difficult and attended by too high a mortality. While the obstruction is overcome by the short-circuiting, the pyloric tumor mass remains intact and unchanged for a number of years, as observed by subsequent laparotomies, autopsies and by Rontgen-ray examinations showing all of the barium passing through the gastro-enterostomy.

The Rammstedt operation, in which a longitudinal incision is made through the tumor mass down to the mucosa with spreading, has become the standard and safest procedure. Its results are not alone successful but the operation is curative. The longitudinal incision through the pylorus produces the transverse division of the circular muscle as in the cutting of a ring and leaves the muscles without an origin or insertion. As a result the circular muscles retract and undergo disuse atrophy with permanent

disappearance of the pyloric tumor mass. The encroaching on the pyloric canal by the infolding of the mucosa is immediately relieved.

In my series of 48 cases two gastro-enterostomies and forty six Rammstedt operations were performed with the loss of one infant. The duodenal mucosa was accidentally opened in two cases, as made evident by the presence of small bile-stained bubbles. A single stitch in each instance closed the opening and the accident in no way affected the convalescence of the patient. Forty-six of these patients were males.

The operation is performed through a short, high, upper right rectus or perimedial incision just long enough to permit of the deliverance of the

pyloric tumor and so short as to prevent any other evisceration. In the ideally performed operation not a single loop of bowel should protrude or even be seen at any time. An incision an inch and a half long usually suffices, and two inches is the maximum length. Unnecessary evisceration is time-consuming, involves exposure and as a result of the manipulation neces-

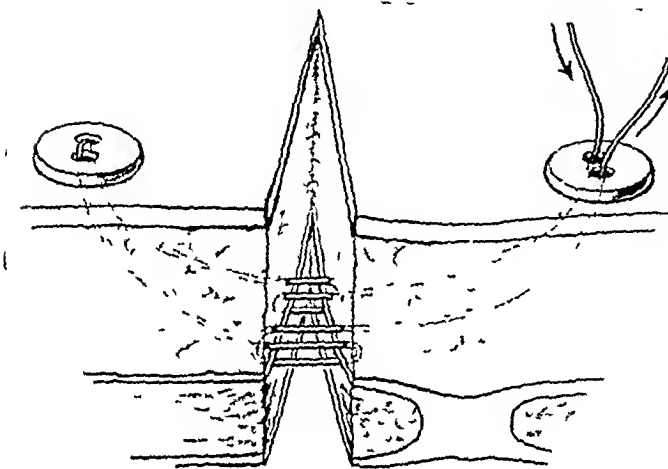


FIG. 51.—Braided silk stay sutures impregnated with wax tied over buttons. Due to the impaired healing qualities of these emaciated infants, thorough support of the wound is necessary.

sary for reduction inflicts a type of shock ill borne by infants. The pyloric tumor is delivered into the wound, and a longitudinal incision is made through an avascular region down to and exposing the pearly white mucosa, which is well liberated by spreading the margins of the wound with a curved Carmalt hæmostat. Scrupulous attention is paid to hæmostasis and all bleeders are sutured. A free portion of the omentum is sutured to the upper margin of the region to prevent adhesions of this area to the liver or other structures, such an occurrence having produced post-operative obstruction with death. The pylorus is returned to the peritoneal cavity and the wound closed in layers.

The operation (Figs 3, 4 and 5) should be rapidly and delicately performed with minimal traumatization. The shortest time from skin incision to skin closure was ten minutes, and the second half of the series averaged from twelve to fourteen minutes. The following factors as employed, while seemingly of minor importance are, in my opinion, major considerations and essential in achieving the highest degree of success. The operating room should be warm and free from drafts. In this series the operating room temperature has been maintained at 80° F and higher. Most of these emaciated infants weighed less than at birth, the body weight being as low as four and a half pounds. The child's extremities and body, with the excep-

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tion of the operative field, are bandaged in cotton batting and surrounded by hot water bottles. A trained surgical team is indispensable to smooth and rapid work. Ether, administered by a skilful anaesthetist familiar with the requirements of paediatric surgery, has been the anaesthetic of choice, and has been employed except in two cases which were done under local anaesthesia. Under local anaesthesia the straining of the infant forces loops of bowel through the wound thus producing the shock factors and time loss referred to above. The surgical team are scrubbed before the anaesthetic is commenced, and the first minute in which surgical anaesthesia and complete relaxation are obtained the operation is started. In other words, the surgeon waits for the patient, and not the patient for the surgeon. It is my opinion that operations performed under general anaesthesia are too frequently begun before the patient is properly relaxed. The stimulation of the too early incision results in a greater quantity of ether being required and is followed by straining, varying degrees of evisceration, which require manipulation and packing, all of which result in trauma, which is shock producing, and may result in the development of post-operative adhesions. All abdominal packs and sponges are wrung out of normal saline, maintained at 110° F by thermometer reading in the solution, thus avoiding the shock produced by either too hot or too cold temperatures and likewise preventing injury to the peritoneum which results in the formation of adhesions.

Infants do not withstand the loss of blood even in small amounts. Hemorrhage in these little ones is synonymous with shock. Strict attention is paid to haemostasis.

On completion of the operation the child is wrapped in warm blankets and returned to its crib, which has been warmed with hot water bottles, the temperature of the water being 110° F, as ascertained by thermometer reading. Feedings are begun in three to four hours after the operation. No transfusions were done in this series of cases. The paediatrician has directed practically all of the post-operative care except the care of the wound. A

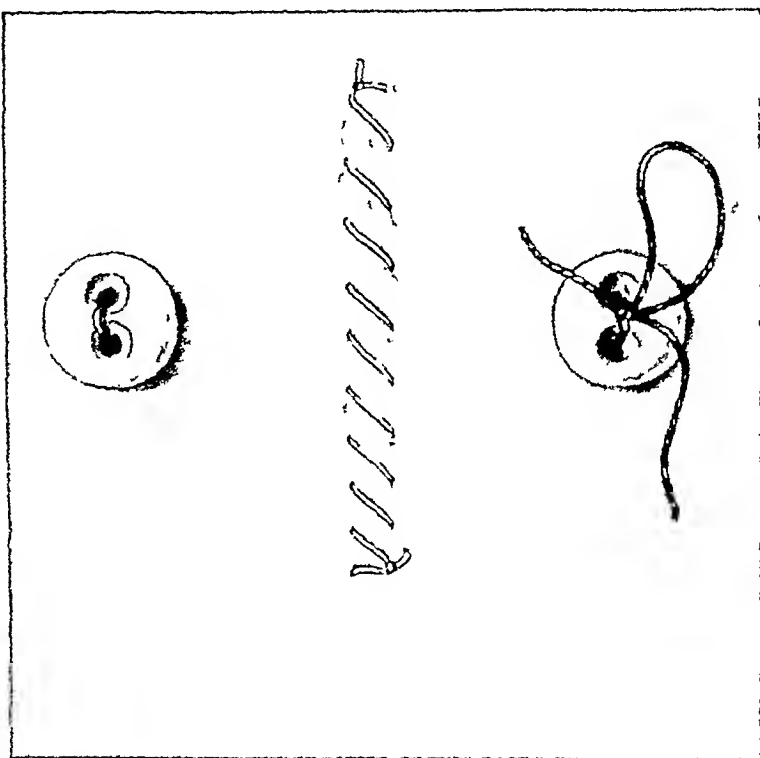


FIG 5b.—Braided silk stay sutures impregnated with wax tied over buttons. Due to the impaired healing qualities of these emaciated infants thorough support of the wound is necessary.

specially trained and experienced pædiatric nurse is valuable during the post-operative and convalescent period

Louis W Sauer, in the *Archives of Pædiatrics*, March, 1924, reviews 761 cases in which the Rammstedt operation was performed with 91 operative deaths, or a mortality of 12 per cent

The following operative results are quoted from an article by W F Fowler, *ANNALS OF SURGERY*, December, 1925 "Poynton and Higgins report 20 cases treated during 1920 and 1921 with an operative mortality of just under 45 per cent The surgical mortality for the 35 patients treated during 1922 and 1923, however, was less than 15 per cent The improvement was due to earlier operations Mixter reports 195 operations during the past ten years with a mortality of 9.5 per cent Strauss, in 1920, reported 103 operations with three deaths Palmer, in 1922, reported 39 operations with two deaths Porter, in 1919, reported 22 operations with two deaths Hill, in 1920, reported 22 operations with one death"

Rodda, in a review of the subject, reported 12 cases treated medically with a mortality of 36 per cent as compared with 17 cases treated surgically with a 5.8 per cent mortality

In my series of 48 cases there was one death, or a mortality of 2 per cent

REFERENCES

- Rammstedt, C *Med Klin*, 1912, vol viii, p 1702 *Centralbl f Chir*, 1913, vol xl, p 3
 Holt, L E *Jour A M A*, 1917, vol lxxviii, p 1517
 Walls, Frank X *Jour A M A*, September 7, 1918, p 811
 Downes, W A *Jour A M A*, July 24, 1920, p 228
 Strauss, A A *Surg Clinics of Chicago*, 1920, vol iv, p 93
 Wollstein, M *Am Jour Diseases of Children*, June, 1922
 Palmer, Dudley W *Archiv of Pædiatrics*, September, 1922
 Oliver, John C *ANNALS OF SURGERY*, October, 1922
 Strachauer, A C *Minnesota Medicine*, March, 1923
 Sauer, Louis W *Archiv of Pædiatrics*, March, 1924
 Davis, H H *Jour A M A*, August 30, 1924, p 686
 Fowler, W Frank *ANNALS OF SURGERY*, December, 1925

DUODENAL DIVERTICULITIS

SECOND REPORT

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MY REASONS for again calling attention to the subject of duodenal diverticulitis are

I Further experience shows that the condition though rare occurs more frequently than was at first supposed

II There are no characteristic symptoms from which a diagnosis can be made clinically

III No technic for the removal of a diverticulum imbedded in the head of the pancreas or in the retroperitoneal space is described in text-books on operative surgery

I *Occurrence* —Since discussing the subject of duodenal diverticulitis at the meeting of this Association in 1922, J C B Giant, Professor of Anatomy in the Medical Department of the University of Manitoba injected with paraffin the duodenum of all cadavers brought to the dissecting room. With surprising regularity he found diverticula present in two out of every twelve specimens examined. In three years thirty-seven bodies were examined and in six, diverticula of the duodenum were present, an average of 16.2 per cent. Baldwin in a series of 105 necropsies found 14, or 13.3 per cent.

It would appear from the foregoing statistics that in the routine roentgenological examination of the gastro-intestinal tract that a large percentage of diverticula are not visualized or are missed by the roentgenologist. Case's statistics show that diverticula of the duodenum are demonstrated in 12 per cent of all barium meal examinations. J C McMillan, radiologist to the Winnipeg General Hospital, found 10 in 653, or 1.5 in every hundred cases. This wide discrepancy between the anatomical and X-ray statistics must be emphasized. In spite of the modern improvements in X-ray technic, it is only 10 per cent efficient in the diagnosis of this very important lesion of the upper abdomen.

II *Diagnosis* —There are no symptoms characteristic of the condition from which a diagnosis can be made clinically. The symptoms simulate those of gastric, as well as extragastric lesions causing gastric symptoms. It is another condition entering into the problem of the "chronic abdomen."

The diagnosis is made by keeping the condition in mind, by a process of elimination and by the aid of the X-ray. The ratio of diverticulitis to diverticulosis must be considered. It has been estimated at 2 in 10, I believe it is higher for cases demonstrated by the X-ray. It is not enough that a pouch

* Read before the Western Surgical Association, October 14, 1926

holding barium is demonstrated, the roentgenologist should go further and determine if possible to which part of the duodenum the diverticulum is attached. The operating surgeon will find that having this exact knowledge beforehand he may yet have the greatest difficulty in locating the pouch, when imbedded in the pancreas or placed posterior to it. Stereo-roentgenograms will aid in determining the relationship of the diverticulum to other structures.

With the abdomen opened the presence of peridiverticulitis will confirm or make the diagnosis, and is a guide to localization of the lesion. Peri-

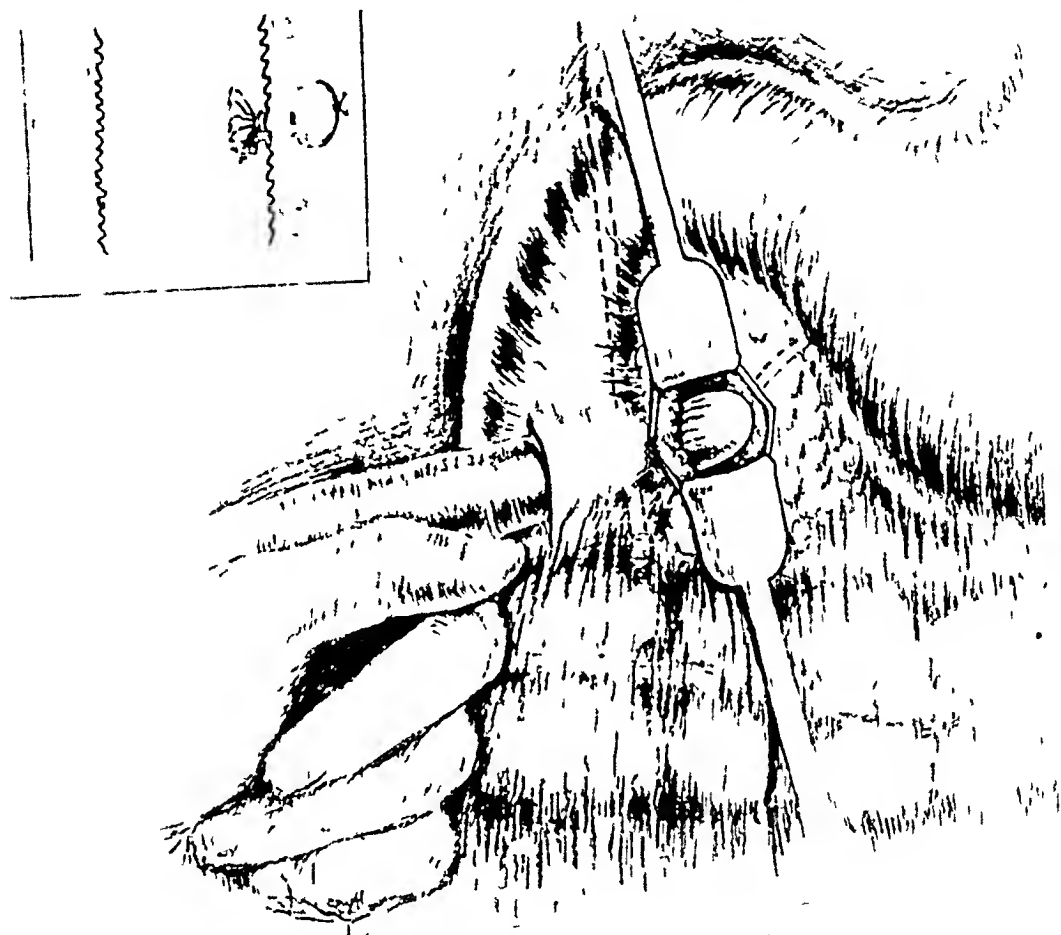


FIG. 1.—Transduodenal diverticulectomy

diverticulitis was strikingly evident in two of my four cases operated on. Both were retroperitoneal. In my last case, however, periduodenitis was the outstanding feature and was in my opinion directly due to the inflamed diverticulum in the retroperitoneal cellular tissue.

My experience has been limited to sixteen cases. In all, the presence of a diverticulum was demonstrated with the X-ray and in none was the diagnosis made clinically. There were four cases of diverticulosis, the symptoms being entirely accounted for by other abdominal lesions. Eight had symptoms presumably due to diverticulitis (*i.e.*, no other cause for their symptoms could be found), but not sufficiently severe to advise surgery. Four cases had extremely severe symptoms and were operated on. Three were entirely relieved of their symptoms. The other was done too recently to be able

DUODENAL DIVERTICULITIS

to report on the end result, though the patient is making a favorable convalescence

III *Operative Technic*—1 Diverticula on the anterior peritonealized surface of the duodenum

2 Diverticula imbedded in the pancreas

3 Diverticula behind the pancreas, or in the retroperitoneal space

Diverticula on the anterior, peritonealized surface of the duodenum offer no surgical problems. They are covered with peritoneum and their removal is simple. If pedunculated they may be ligated at the base, the stump cauterized and buried with a purse-string suture. It is well to anchor a corner of the great omentum over the place for greater security. If sessile or wide at the base, excision or simple inversion with Lembert sutures placed so that the suture line is transverse to the long axis of the duodenum will suffice.



FIG 2—Mobilization of third part of the duodenum and removal of diverticulum attached to fourth part

A diverticulum imbedded in the head of the pancreas or behind it in the retroperitoneal tissue presents much greater difficulties. The radiologist may tell us from which part of the duodenum it originates, but cannot tell us whether or not it is imbedded in pancreatic tissue. In my first case I got the clue from the pancreas being greatly thickened and indurated. The method of removal is shown in Fig 1, and is described in my former article, *Surg, Gynec and Obst*, July, 1903.

A diverticulum behind the pancreas in the retroperitoneal cellular tissue will require mobilization of the duodenum and head of the pancreas for its removal. If attached to the first or second parts, mobilization after dividing the parietal peritoneum along the right border of the duodenum, reestablishing the embryological condition before rotation had taken place, will expose the posterior surface of the duodenum and head of the pancreas. This method of mobilization of the duodenum is used in other operations such as, the Phinnny operation of pyloroplasty and in duodeno-choledochotomy.

Diverticula attached to the third and fourth part of the duodenum and behind the pancreas may be removed by a method which I used and which I have not seen described. The transverse colon with its mesocolon and great omentum are turned upwards, exposing that part of the duodenum (third part) below the attachment of the transverse mesocolon. The posterior

parietal peritoneum is incised along its lower border, the right colic artery being avoided. The superior mesenteric vessels are drawn to the left. This exposes the posterior surface of the third and fourth parts of the duodenum and the posterior surface of the head of the pancreas (Fig 2). In the case here recorded, the diverticulum was with some difficulty found imbedded in the cellular tissue behind the pancreas.

While there is no question about the advisability of drainage in an intra-peritoneal operation, removal of a diverticulum from the retroperitoneal cellular space with tissue so vulnerable to the slightest infection calls for at least a temporary drain.

CASE I—W. W. F., female, age forty-four, October 15, 1925

Primary Complaint—1 Stomach trouble—twenty years 2 Gaseous cructations 3 Nausea and vomiting 4 Loss of weight—thirty-five pounds in twelve months

Previous History—1 Infectious fevers in childhood 2 Operation, 1923 Appendectomy and salpingectomy

Present Illness—Began twenty years ago with attacks of nausea and vomiting, lasting about one week. These spells would recur two or three times a year. No change occurred until about



FIG. 3—Diverticulum attached to first part of duodenum associated with pyloric obstruction

April, 1925, when she had a particularly prolonged spell and since then the attacks have been very frequent. Attacks usually came on at night, which were partly relieved by taking soda and vomiting. No abdominal pain at any time. The first attack occurred at eighteen years of age. Vomitus was "coffee ground" in appearance. Stool was black. No dark vomitus or melena since. Lately has been vomiting large quantities, as much as two quarts. During first few years attacks associated with some diarrhoea.

Appetite fairly good. Belches a great deal of gas between attacks. Has lost thirty-five pounds in weight during past twelve months. Stomach is upset when she becomes excited. This has led to a diagnosis of nervous dyspepsia. No urinary symptoms. No pulmonary or cardiac symptoms. Menses normal and regular. No pregnancies.

Examination—No apparent oral or nasopharyngeal sepsis. No enlarged supra-clavicular glands. *Abdomen*—Fulness in epigastrium. No tenderness. Supra-pubic scar. No mass. *Pelvic*—Negative. *Rectal*—Negative. *Heart and lungs*—Negative. *Pulse*—74. *Blood-pressure*—120/86. *Gastric Analysis*—Free HCl, 68, total, 118. *Urnalysis*—1032, clear ambre acid. Sugar and albumin negative. Micro, negative. *X-ray*—The stomach is very large, possibly three times its normal size. The pylorus is cut off, and

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the first part of the duodenum is poorly filled. There is a gastric residue at the end of twenty-four hours. This would indicate a pyloric obstruction, possibly due to ulcer. A diverticulum is seen attached to the first part of the duodenum (Fig 3).

Operation, October 26, 1925—1 Posterior gastro-enterostomy 2 Invagination and purse-stringing duodenal diverticulum

Notes—Stomach was very large. Gall-bladder was negative. There was a duodenal pouch, size of a walnut, on the anterior surface of the duodenum immediately beyond pyloric ring. There was some thickening and induration of the duodenum at the base of the diverticulum. Pylorus was thickened. No ulcer could be demonstrated.

CASE II—Diverticulum imbedded in head of pancreas. History and operation fully described in *Surgery, Gynec and Obst*, July, 1923.

CASE III—M. M., male, age thirty-seven, occupation farmer, January 26, 1925.

Family History—Father died aged sixty-four (paralysis), mother living and one sister.

Marital History—Marriage age twenty-three—six children living and healthy.

Previous Diseases and Injuries—Pneumonia, grippe, tonsillitis.

Chief Complaints—1 Stomach trouble 2 Pain in epigastrium, referred through to back 3 Constipation 4 Loss of weight.

General Description of Patient—Rather undernourished.

Clinical History—About three years ago he began to

have pains in the epigastrium, but these did not trouble him much for a year. They have gradually been getting worse and lately have been so severe that he has been unable to do his work properly. The pain comes on about five minutes after eating and is referred through to the back. Not up to the right shoulder. Lately it has been so bad that he has been unable to sleep at night. Years ago he vomited occasionally but has not lately. When hungry he gets dizzy and weak and can hardly see anyone. Is constipated and always has to take medicine for the bowels. No other complaints.

Patient states that he is often afraid to eat even when hungry on account of pain in the stomach five or ten minutes after eating. For the last year he has not been able to work hard because the pain is severe then. He feels dull and drowsy and finds it very difficult to get up in the morning as he feels tired and aches all over.

Physical Findings—Tonsils small but ragged. Infection—no pus could be expressed. Tenderness over duodenum. Slightly tender over appendix.

Urinalysis—January 27, 1921, albumin, sugar negative. January 30, 1916, albumin faint trace, sugar negative.

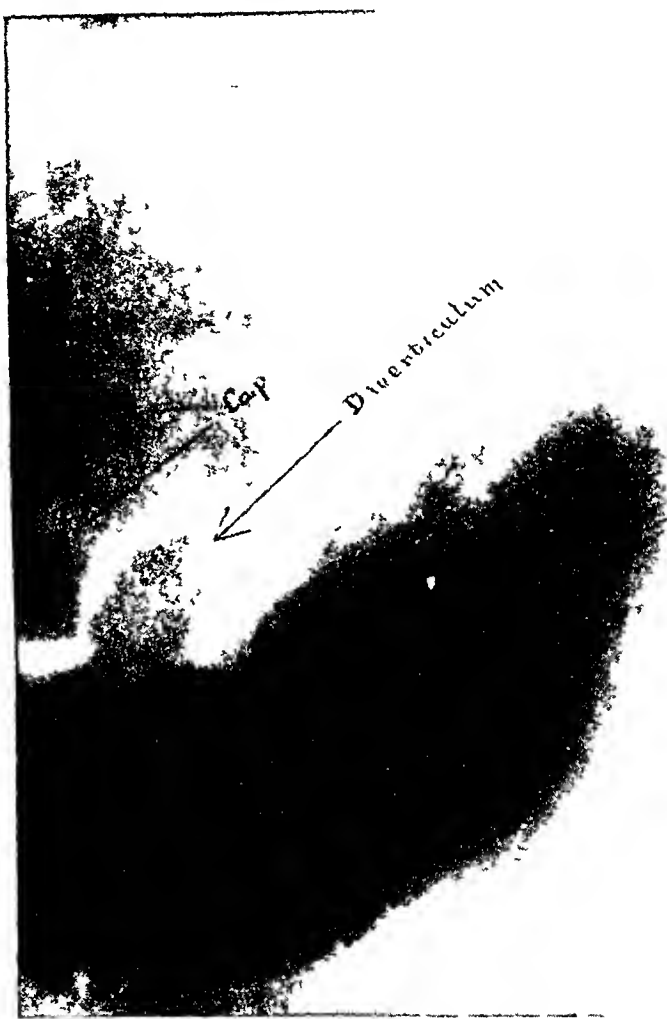
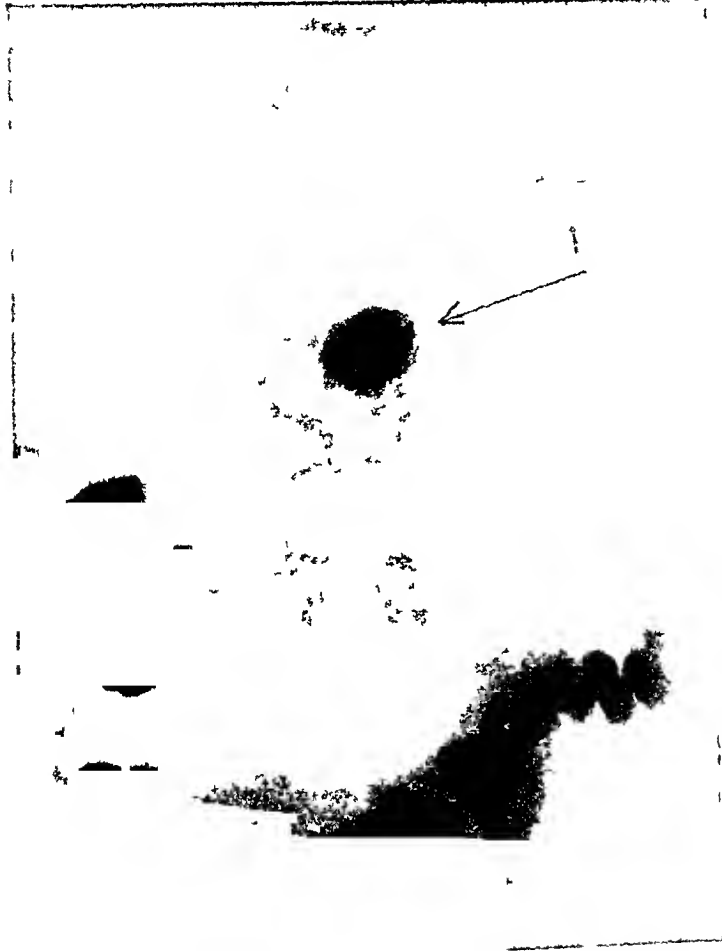


FIG 4—Diverticulum of duodenum attached to fourth part

Test Meal—Total acidity 42, HCl 12, combined HCl 30 Food remnants not free until one and a half hours

X-ray Report—Stomach and duodenum negative Duodenal diverticulum shown

X-ray Report and Examination of Stomach—Fluoroscopic examination showed no six-hour retention in the stomach, though there was some barium which appeared to be either in the duodenal cap or in a diverticulum, the rest of the small bowel was empty The appendix was plainly visible and appeared long and rather evenly filled On examination the stomach outline appeared regular, peristalsis normal, and showed no filling defect Stomach negative



The duodenal cap was also seen to fill to the right of and to be separate from the barium previously noted As the cap emptied, the course of the duodenum could be traced and the ascending portion was seen to be more to the right than usual and to ascend higher than normal and just after this turned to the left the barium was seen to flow into a diverticulum, which hung downward and to the right This diverticulum could be about half emptied by pressure It appeared to be one inch and a half in length and to have a wide base (Fig 4)

The plate taken twenty four hours later showed the diverticulum about half filled with an air bubble filling in the fundus (Fig 5)

A forty-eight-hour plate showed the diverticulum emptied The barium was still seen in a very low and narrow transverse colon

FIG 5—Barium and air bubbles in diverticulum attached to fourth part of duodenum Twenty-four-hour plate

Operation—Right transverse incision above umbilicus To get more room it was continued upward midline vertical for two or three inches (Perthes' incision), exposing stomach, duodenum (first and second parts) and gall-bladder No pathology could be seen Turning up the great omentum, transverse colon, and mesocolon showed these strictures adherent to the posterior parietal peritoneum, especially that covering the third and fourth parts of the duodenum and right side of the mesentery Those strictures to the left of the superior mesenteric vessels were free from adhesions Separating it and the pancreas was examined, but no trace of the diverticulum could be found This part of the duodenum was then mobilized from the posterior abdominal wall and turned upwards The mesentery and superior mesenteric vessels were drawn to the left After a careful search, a slight thickening was seen on the posterior and upper border of the duodenum, behind the head of the pancreas Separating the fascial covering at this point with the blades of dissecting scissors, the diverticulum came into

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view (Fig 2) It was found buried in the cellular tissue behind the head of the pancreas and attached to the fourth part of the duodenum When entirely freed a clamp was applied near its base A purse-string was run about the base and a ligature placed a quarter of an inch below the clamp The diverticulum (Fig 6) was removed by cutting between clamp and ligature The stump was carbolized and inverted into the duodenum and the purse-string tied The duodenum was allowed to fall back into its normal place A drainage tube was inserted down to the lower border of the duodenum to drain the opened cellular space The tube was passed outward through a small hole in the transverse mesocolon and brought to the surface through a separate stab wound in the abdominal wall The transverse colon was returned into the abdomen in its normal position The appendix which showed slight pathology was removed and the abdomen closed

Comments—The adhesions between the right half of the transverse colon and mesocolon and duodenum pointed conclusively to an inflammatory lesion in this region and could only be explained by the presence of the diverticulum, no other pathology being demonstrated

A large part of the credit for the successful termination of this case is due to Dr R B McQuay, of Portage la Prairie, who made the X-ray examination He definitely showed that the barium was diverted into a pocket from the fourth part of the duodenum Without this exact knowledge, I am sure I could not have found the diverticulum and the case would have gone on record as many others have done, "diverticulum shown by X-ray but not found at operation" This exact X-ray localization is not often done and may not always be possible, but it is essential if the operation is to proceed in an intelligent way for the removal of a diverticulum from the post-peritoneal or post-pancreatic space



FIG 6 —Diverticulum $2\frac{1}{2}$ by $3\frac{1}{2}$ cm

CASE IV—A T, female, October 6, 1926

Primary Complaints—1 A boring pain in epigastrium, slightly to the right of midline (two years) 2 Great distention with gas and much belching (three years) 3 Constipation and passing of mucus (two years) 4 Headaches with vomiting 5 Loss of weight—forty-five pounds in three years, one hundred and thirty-five pounds to ninety pounds

Family History—Negative No tumors, tuberculosis or nervous diseases

Previous History—Always healthy till 1918, when she had fibroids removed and appendectomy Womb not removed No children Had pleurisy in 1915 It was tapped and a quart of fluid removed She seemed to recover perfectly Tonsillectomy ten years ago

Present Illness—Three years ago began to have headache and vomiting Right side of head and down back of the neck She always has to have the back of her neck rubbed and also between the shoulders Has "neuritis" in arms and hands This seems to come from the back Headaches are not so frequent now as formerly Has an "awful taste" in her mouth and feels as if there was poison in her system Food does not relieve, but now if she goes a long time, four or five hours, she gets a gnawing pain, which is easier after eating She does not eat well when she has the distress She has been eating better lately, at times, but loses her appetite and feels miserable again

The aches and pain in the right epigastrium and right hypochondrium go through to the back, lower dorsal and under right shoulder The ache would go up the right side of the neck and "come out of the right ear" She said the glands in right side of the neck would be tender to touch

In 1924, she went to bed for fourteen weeks and was on Sippy treatment, but did not improve. Went through two climates and was ten weeks in sanatorium.

In 1925, she felt the cold so much she would shiver after a bath. Has weak spells and sweats a great deal. Her hands and feet swell at night. Sent to California for the winter, then went to Tennessee for several months. Returned to Winnipeg for the summer months. Stayed at Vancouver on her way home and a doctor drained her gall-bladder with a Raflus tube. Has taken belladonna 1 d for months.

Examination—A slightly undernourished woman. Medium height. Suprapubic scar. Abdomen full. No mass felt. Note tympanitic. Liver and spleen negative. Tenderness at Mayo-Robson's point and pressure here causes pain to shoot directly through to back, about twelfth rib, or just below it in costo-vertebral angle. P V, negative. P R, hemorrhoids otherwise negative.

X-ray Report—During and immediately following ingestion of opaque meal. The stomach is orthotonic, regular in outline and freely movable. The duodenal cap is normal.

Five-hour examination—The stomach is empty and there is a blob of barium opposite the body of the third lumbar vertebra. This was at first thought to be some of the opaque mixture retained in the crater of an ulcer.

Twenty-four-hour examination—At this time there is some of the barium in this sack.

Forty-eight-hour examination—The meal is through out the large bowel. The sack is apparently empty. The colon has a spastic stringy appearance.



FIG 7—Diverticulum of third part of the duodenum
Five-hour plate

Summary—The sack which was seen at the previous examinations and thought to be crater of an ulcer, but on further study are now inclined to think it is a diverticulum of the third portion of the duodenum.

Operation—High right paramedian incision. October 7, 1926, exploration of the stomach negative. Gall-bladder normal. (No stones, adhesions or thickening.) Kidney and spleen negative to palpitation. The duodenum was covered with an inflammatory veil, but no sign of ulcer and apparently not dilated. The great omentum was adherent to the incision of former operation in the lower abdomen.

Transverse colon and mesocolon were not adherent to the posterior parietal peritoneum as was noted in Case III.

The duodenum was mobilized by dividing the parietal peritoneum along its right border where it with the head of the pancreas could be turned to the left, exposing the posterior surface. The diverticulum was with difficulty located imbedded in cellular tissue attached to the third part (transverse part) of the duodenum. After ligature and carbolization of the stump it was inverted into the lumen of the duodenum by a double

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purse-string of No 0 chromic catgut A drainage tube was inserted down to the retro-peritoneal space and brought out through a stab wound in the right flank and the incision closed

Convalescence uneventful

BIBLIOGRAPHY

- Aitken, H F Report on Sixty-four Consecutive Examinations of Duodenum on Cadaver Boston M and S J, 1921, vol clxxxiv, p 67
- Andrews, E Willis Duodenal Diverticula J Am M Assn, Chicago, 1921, vol lxxvii, pp 1309-1311
- Baensch, W Zur Röntgendiagnostik des Duodenaldivertikels unter spezieller Berücksichtigung seiner Ätiologie Fortschr a d Geb d Röntgenstrahlen, Hamb, 1923, vol xxx, pp 322-326, 1 pl
- Bauer, T Ueber das Duodenaldivertikel Wien klin Wchnschr, 1912, vol xxv, p 879
- Bell, H H Diverticula of the Duodenum Anat Record, Phila, 1921, vol xxi, pp 229-237
- Berblinger Grosses paariges Divertikel des Duodenum Munchen med Wchnschr, 1918, vol lxxv, p 113
- Bonneau, R Les diverticules du duodenum Presse med, Par, 1923, vol xxxi, pp 817-819
- Braithwaite, V A Case of Diverticulitis of the Small Intestine Guy's Hosp Gaz, London, 1918, vol xxxii, p 77
- Butler, P F Diverticulum of the Duodenum Boston M and S J, 1925, vol cxcii, pp 705-712
- Caraven, J Diverticulum of the Duodenum Presse med, Par, 1923, vol xxxi, p 1084
- Carnot, P, and Peron, N Volumineux diverticule duodenal de la 4e portion, considerations radiologiques et anatomiques Arch D mal de l'appar Digest (etc), Par, pp 914-919
- Carnot, J, and Peron, N Volumineux diverticule duodenal de la 4e portion, diagnostic radiologique et controle anatomique Bull et mem Soc med d hôp de Par, 1924, 3 s, vol xlviii, pp 1222-1224
- Case, J T Diverticula of Small Intestine, Other Than Meckel's Diverticulum J A M Assn, Chicago, 1920, vol lxxv, pp 1463-1470
- Chaton Trois observations de diverticules de la premiere portion du duodenum, constatées d'ur des pieces de pyloréctomie Bull et mem Soc anat de Par, 1922, vol xcii, pp 211-217
- Clairmont, P, and Schinz, H R Zur Diagnose und Chirurgie Der Duodenal divertikel Deutsche Ztschr f Chir, Leipz, 1920, vol clxx, pp 304-361
- Cole, L G, and Roberts, D Diverticula of the Duodenum Surg, Gynec and Obst, Chicago, 1920, vol xxxi, pp 376-382
- Cullen, E K Diverticulum of the First Portion of the Duodenum Arch Surg, Chicago, 1921, vol ii, pp 542-546
- Cullen, E K Report of a Diverticulum of the First Portion of the Duodenum Tr South Surg Assn, 1920, Phila, 1921, vol xxxiii, pp 364-369, 2 pl
- Davis, N S Diverticula of the Duodenum Tr Chicago Path Soc, 1913, vol ix, pp 1-7, 2 pl
- Divis, J Pseudodiverticula of the Duodenum in Peptic Ulcer Casop lek cesk, Praha, 1925, vol lxiv, pp 8, 61
- Downes, W A Duodenal Diverticula ANNALS OF SURGERY, Phila, 1922, vol lxxvi, pp 43-51
- Downes, W A Duodenal Diverticula, With the Report of Four Cases Tr South Surg Assn, 1921, Phila, 1922, vol xxxiv, pp 52-67, 3 pl (discussion), pp 76-83
- Feissly Un diverticule de l'angle inferieur du duodenum, diagnostique par la radiographie Rev med de la Suisse Rom, Geneve, 1922, vol xlii, p 121

- Ficssly, R Diverticule de l'angle inferieur du duodenum diagnostique par la radiographie (verification operatoire) *J de radiol et d'electiol*, par, 1922, vol vi, pp 69-73
- Forssell, G, and Key, E A Case of Diverticulum of the Duodenum, Diagnosis by the Rontgen-rays, Excision *Hygien*, Stockholm, 1915, vol lxvii, p 63
- Glans, A Zur Lehre der kongenitalen Darmdivertikel *Schweiz med Wchnschr*, Basel, 1920, vol I, p 1024
- Grant, J C B Duodenal Diverticula *J Anat*, Lond, 1922-1923, vol lvi, pp 357-359
- Gutierrez, J Diverticulos duodenales (tres casos) *Semana med*, Buenos Aires, 1922, vol xxix, pp 309-315
- Hartung, A Diverticula of the Duodenum *Radiology* St Paul, 1925, vol I, pp 308-318
- Hundck, M Zur klinischen Beduetung der Duodenal-divertikel *Wien klin Wchnschr*, 1924, vol xxvii, pp 776-779
- Hofmann, H H, and Kauffmann, F Traktionsdivertikel des Duodenums, rontgenologisch diagnostiziert und operative entfernt *Zentralbl f Chir*, Leipz, 1921, vol xlviii, pp 650-653
- Holzweissig, H Ein Beitrag zur Kenntnis der Duodenaldivertikel *Mitt a d Grenzgeb d Med u Chir*, Jena, 1921-1922, vol xxix, pp 527-553
- Huddy, G P B Duodenal Diverticula, With Report of a Case of Gangrenous Diverticulitis *Lancet*, Lond, 1923, vol II, pp 327-330
- Hunt, V C, and Herbst, W P False Diverticulum of the Duodenum Containing Gallstones, With Cholecystdiverticular Fistula *Surg Clin N Am*, Phila, 1925, vol v, pp 807-811
- Jones, W H Report of a Case of Diverticulum of Duodenum With Ulcer on Opposite Wall *J Am M Assn*, Chicago, 1922, vol lxxviii, p 1706
- Keller Quatre cas de diverticule du duodenum *Radiographie en serie* *Bull et mem Soc de radio med de France*, Par, 1922, vol x, p 180, 1 pl
- Latarjet, A, and Murard, J Les diverticules de l'intestin grele (diverticule de Meckel excepte) *Lyon chir*, 1914, vol xi, pp 425-460
- Le Noie P, and Bariety, M Les diverticules du duodenum *Medecine*, Par, 1923-1924, vol v, pp 758-762
- Le Noir, Gilson, and Bariety Un cas de diverticule du duodenum *Arch d mal de l'appar digest (etc)*, par, 1924, vol xiv, pp 252-257
- Lewis, D A Duodenal Diverticulum *J Am M Assn*, Chicago, 1921, vol lxxvi, p 783
- Linsmayer, H Ueber Duodenaldivertikel *Verhandl d deutsch path Gesellsch*, Jena, 1914, vol xvii, pp 445-455
- Lipshutz, E W Duodenal Diverticulosis With Report of a Case Seen Rontgenologically *Am J M Sc*, Phila, 1925, vol clxx, pp 53-57
- Lotsy Vortauschung eines Duodenumdivertikels durch eine verkalkte Mesenterialdruse oder durch Kalkablagerung in der Darmwand *Fortschr a d Geb d Rontgenstrahlen* Hamb, 1923, vol xxx, pp 212-214, 1 pl
- Maclean, N J Diverticulum of the Duodenum, With Report of a Case in Which the Diverticulum was Imbedded in the Head of the Pancreas, and a Method for its Removal *Surg, Gynec and Obst*, Chicago, 1923, vol xxxvii, pp 6-13
- Mayo Charles H Diverticula of the Gastro-intestinal Tract, Their Surgical Importance *J Am M Assn*, Chicago, 1912, vol lix, pp 260-264
- Meyer, A W Resessus duodeno-posterior (Broesicke) *J Anat and Physiol*, Lond, 1913-1914, vol xlviii, pp 147-149
- Montanari, A Diverticulo duodenale perivateriano *Radiol med*, Milano, 1923, vol x, pp 445-449
- Moore, E C Duodenal Diverticula, With Report of a Case *Arch Surg*, Chicago, 1920, vol I, pp 513-523

DUODENAL DIVERTICULITIS

- Morrison, T H, and Feldman, M Case of Carcinoma in Duodenal Diverticulum with Consideration of Duodenal Diverticulosis *Ann Clin Med*, Balt, 1925, vol cv, pp 403-414 (Illus)
- Murchison, D R Duodenal Diverticulum With Pyloric Ulcer *J Am M Assn*, Chicago, 1920, vol lxxv, p 1329
- Nagel, G W Unusual Conditions in Duodenum With Their Significance, Membranous Obstruction of Lumen Diverticula and Carcinoma *Arch Surg*, Chicago, 1925, vol xi, pp 529-549 (Illus)
- Novaro, R, and Galindez, A Diverticula of the Duodenum *Rec Asoc med argent*, Buenos Aires, 1921, vol xxv, p 607 Abs, *J Am M Assn*, Chicago, 1921, vol lxxvii, p 1929
- Novaro, R, and Galindez, A Diverticulos del duodeno *Rev Asoc med argent*, Buenos Aires, 1921, vol lxxv, Sect Soc de chirug, pp 39-51
- Oehnell, H Zur Frage der klinischen Bedeutung der Duodenaldivertikel *Arch f Verdauungskr*, Berl, 1923, vol xxxi, pp 127-174
- Penhallow, D P A Case of Duodenal Diverticulum *J Am M Assn*, Chicago, 1923, vol lxxx, pp 1372-1374
- Robineau Diverticule du duodenum *Bull et mem Soc de chir de par*, 1921, vol xlvii, p 970
- Robincan, M, and Galhy Diverticule de la quatrieme portion du duodenum *Arch d mal de l'appar digest (etc)*, Par, 1922, vol xii, pp 103-108
- Saraceni, F Nicchie e diverticoli duodenali *Radiol med*, Milano, 1921, vol cx pp 189-195
- Saraceni, F Nicchie e diverticoli duodenali *Atti d Cong ital di radiol med*, 1920, Milano, 1921, vol iii, pp 189-195
- Schaefer, H Kongenitale Anomalie des Duodenums mit Divertikelbildung *Fortschr a d Geb d Rontgenstrahlen Hamb*, 1922, vol xxix, p 776
- Siegrist, H Diverticulum in a Man of Forty-eight *Cor Bl f schwiez Aertze*, 1919, vol il, p 47
- Spriggs, E I Diverticula of the Duodenum *Brit J Surg Bristol*, 1920, vol viii, p 18
- Spriggs, E I, and Marxer, O A Intestinal Diverticula *Brit M J*, Lond, 1926, vol i, pp 130-134 (Illus)
- Tyler, A F Diverticula of the Duodenum *Nebraska M J*, Norfolk, Neb, 1921, vol vi, pp 41-46
- Versman, G M Ueber Divertikel des Duodenums und deren Zusammenhang mit Gallensteinleiden *Beitr z klin Chir*, Tubing, 1919-1920, vol cxviii, pp 735-748
- Weinstein, S Duodenaldivertikel Am Lebenden diagnostiziert *Med Klin*, Berl, 1920, vol xvi, p 905
- Wilensky A O Duodenal Diverticula *Progr Med*, Phila, 1923, vol ii, p 107
- Wilkie, D P D Duodenal Diverticula and Duplication of the Duodenal Wall *Edin M J*, 1913, n s, vol xl, pp 1219-1229, 4 pl Also, *J Path and Bacteriol*, Cambridge, 1912-1913, vol xvii, p 421

DIVERTICULITIS OF THE SIGMOID*

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THERE are four places in the intestinal tract where the onward flow of contents is normally retarded, the pylorus, ilio-cæcal junction, sigmoid and anus. These regions are more freely supplied with the annodal tissue of Kieth than other portions of the tract and are subject to the natural laws of the influence on motility and secretion resident in this tissue.

It is rationally claimed by clinicians of wide experience and mature judgment that 90 per cent of all diseases of the gastro-intestinal tract occur in one or the other of these locations.

Pathological lesions involving the pyloric, ilio-cæcal and anal regions have long engaged the attention of physicians, their symptoms and management are now well in hand, but study of disease of the sigmoid, until quite recently, has been singularly neglected.

Although reference was made by Virchow in the middle of the nineteenth century to a pathological condition which we now believe to have been diverticulitis of the sigmoid, nearly fifty years elapsed before Grassei recognized and described this disease as a clinical entity.

Almost another decade passed, 1907, before the subject was taken up by W J Mayo, thoroughly studied and presented to the profession, since which time there has accumulated an extensive and increasing literature on diverticulitis. Many theories pertaining to causative factors in the production of diverticula of the sigmoid have been presented, the condition being commonly attributed to constipation and overdistention of the sigmoid by increased internal pressure from fecal contents and gas. Such causes are inadequate in the absence of some inherent defect in the bowel wall, if this were not so diverticula would be far more prevalent. Arrest in the development of the muscular coat has been suggested as a cause and is reasonably acceptable as one of the prerequisites to constipation and overdistention.

In the sigmoid of the embryo the longitudinal muscular fibres spread laterally in the bowel wall to within a short distance of the mesenteric border, the rest of the muscular coat is composed of circular fibres. In the area covered by circular fibres there are a number of little sacculations which normally disappear, along with the recessus intersigmoideus in the developmental changes, persistence of these little sacculations, perhaps constitutes the primary step in the passage of the mucous pouch through the muscular coat of the sigmoid. Spasm in the bowel wall with its concomitant retarding influence on the fecal stream, blood and lymph supply is also an important factor in the mechanics of diverticula.

* Read before the Western Surgical Association, October 14, 1926

DIVERTICULITIS OF THE SIGMOID

By analogy one must conclude that spasm plays an important rôle in pathological processes encountered in the sigmoid. The diverticulæ appear as a series of hillocks on the serous surface of the bowel which may be mistaken for appendices epiploicæ.

Diverticulæ of the sigmoid vary in size and number, they are usually small, about the size of a .32 calibre missile and few in number, three to six or eight.

Pouches as large as a hulled walnut with a sessile base have been described. The smaller ones are pedunculated and some of them contain fecaliths of such density as to resemble a foreign body, those which are empty may, by pressure, be made to disappear into the lumen of the bowel.

In some specimens examined post-mortem the hernia-like protrusions of the mucosa were most numerous near the place of entrance of the blood supply to the bowel, thus in a measure, confirming the law of Harrison relative to intestinal hernia, *viz* that they are prone to follow the course of the blood-vessels.

From the area of foetal sacculations the diverticula spread laterally into the field covered by longitudinal fibres, in some instances involving almost the entire circumference of the sigmoid, diminishing in size and number as the distance increased from the mesenteric attachment.

The lumen of the sigmoid in non-ulcerative subjects was markedly increased, the wall was very thin in the intervening spaces between the diverticulæ and the muscular fibres were attenuated by mechanical pressure and disuse or perhaps from congenital malformation.

In one specimen the muscular tract appeared to be well developed, the fibres constricting the neck of a diverticulum so tightly as to cause separation of the mucous pouch from its pedicle. This mucous sac, partly filled with a thin fluid, was between the muscular and serous coats, completely detached from its pedicle and surrounded by partly organized plastic exudate.

The process was evidently of recent origin and would no doubt have perforated had the patient lived, it was found in a subject dead of accidental drowning.

In chronic cases wherein the diverticulæ are complicated by infection, ulceration and perisigmoiditis, the lumen of the sigmoid is greatly diminished, amounting in some instances to angulation, deformity and complete obstruction. The devitalizing influence of internal pressure from spasm, fecal contents, glandular secretions and œdema favor germ invasion, necrosis and perforation of a diverticulum into a neighboring viscus, the peritoneal sac or the lumen of the sigmoid.

Perforation into the bowel is the most favorable, perhaps the most frequent result in this local necrotic process, which in such cases continues as an ulcer of the mucosa at the site of perforation. Adhesions between the sigmoid and another loop of bowel of the urinary bladder may lead to perforation into either viscus.

Accompanying diverticulitis there is usually a localized peritonitis with the

formation of a protecting plastic exudate which may, and in the greater number of instances does, prevent the calamity of perforation. Acute diverticulitis is comparable to acute infection in any other segment of the tract modified by anatomical construction and functional mechanism of the structures involved.

The symptoms so closely resemble those of acute appendicitis that the disease has been called left-sided appendicitis. This is true not alone of the early manifestations of the disease, pus, gangrene and perforation may rapidly follow the onset of symptoms and complete the analogy.

Muscular rigidity of the lower abdominal wall, pain in the region of the umbilicus radiating into the pelvis or left lumbar region, with frequency, a variable increase in temperature and pulse rate are the usual findings in acute diverticulitis. Nausea and vomiting sometimes accompany the symptoms and marked relief of short duration usually follow a free bowel movement.

Perforation may occur in a primary attack and this should be kept in mind while operating for acute perforation.

The upper end of the sigmoid has a very short mesentery and is covered by peritoneum only on the anterior and lateral aspects in 90 per cent of the cases, this anatomical arrangement favors perforation outwardly, the pus and feces burrowing between the bowel and the ilium downward into the pelvis. The following record of a patient seen many years ago by the writer illustrates some of the clinical features of acute diverticulitis with perforation.

The patient, a woman, aged thirty, had been ill for two weeks. Her chief complaint had been of severe pain in the lower abdomen, as she was pregnant and nearing term, the pain was mistaken for labor pains. The attack was accompanied by fever, her temperature at one time reaching 103° F. She was obstinately constipated, her feet and legs were swollen and the urine contained albumin and casts. Ten days after the beginning of her illness labor was induced and she was delivered of a dead fetus.

Four days after delivery, when the writer first saw the patient, there was a large boggy mass opposite the left iliac spine and a fluctuating mass in the region of the left kidney. Vaginal examination revealed a tumor in the region of the left broad ligament to which fluctuation was imparted by tapping on the abdominal wall near the ilium. The diagnosis was, cellulitis of the left broad ligament with abscess formation.

An incision just within the ilium released a large quantity of dark, grumous material with a strong fecal odor. Another incision in the lumbar region was followed by similar results. A drainage tube was inserted into either opening and the patient's condition, which had been bad prior to operation improved rapidly. The fecal fistula in the lumbar region closed in two weeks, the other opening discharged for five months and finally closed without further operation. The patient recovered, had marked relief from her constipation and was in good health one year later. This record bears the date of 1909, a time when surgeons were not thinking in terms of left-sided appendicitis, and although the diagnosis was wrong, fortunately for the patient, the right thing and no more was done to relieve existing conditions.

The diagnosis of acute diverticulitis is now fairly accurate in consequence of increased clinical experience and the signal assistance which has been rendered by X-ray studies in the last ten or twelve years.

One soon learns that attempts at closing these perforations at the primary

DIVERTICULITIS OF THE SIGMOID

operation are futile, the bowel wall is oedematous, the sutures yield and the tissues fail to heal. There is, however, a favorable tendency to spontaneous closure after drainage, which may be hastened by direct exposure to the sun's rays and the use of bismuth paste.

In the chronic form of the disease, the patient gives a history of having had repeated attacks which were followed by headache, nausea, loss of appetite, joint involvement and other symptoms of faulty elimination.

A tumor may be felt in the region of the sigmoid. These patients are usually constipated but may have troublesome attacks of diarrhoea which will be benefited by repeated, round doses of castor oil.

The differential diagnosis should include special reference to lues, tuberculosis and malignancy.

The sigmoidoscope in our hands has added nothing to the certainty of diagnosis in the acute form of the disease owing to the pain occasioned by its use, it may, however, be very serviceable in the chronic cases wherein the lumen of the sigmoid is not distorted. A correctly interpreted roentgenogram is the best aid to diagnosis.

Objectives in the management of chronic diverticulitis include removal of focal infection, relief of constipation, regulation of diet, rest in bed, and the use of drugs as indicated. Such treatment will benefit many of these patients, but if a tumor be present the unhappy thought comes to mind of the possibility of malignancy, either co-existing or developing later in the margin of an ulcer and of temporizing until the favorable time for removal will have passed. Blood in the stool speaks for ulcer, but does not indicate the character, whether malignant or benign.

If we will remember the clinical dicta, that an inflammatory disease is wavy in its course, that the symptoms come and go, that cancer is a continuous destructive process, it will assist in making the diagnosis. Resection of the sigmoid with end-to-end anastomosis is the ideal treatment for diverticulitis and the tendency at present as indicated in the literature is to strive for this ideal. Operative mortality is too great in unselected patients to warrant this practice. Resection in selected patients is a comparatively safe procedure, but in debilitated or aged patients the mortality is high, they are prone to develop pulmonary complications, infections, pericarditis or joint involvement after operation.

We have found that by giving the patient opium for two or three days prior to, and an intravenous saline injection at the time of operation, lessens the operative risk of resection. In patients requiring operation, results will be infinitely better if operation is done in two or three stages. A preliminary colostomy with sufficient interval to permit of subsidence of the accompanying inflammatory changes before attempting resection and reestablishing continuity of the bowel, will be followed by less operative mortality and better end results than those following complete primary operation.

Mikulicz technic as modified by C. H. Mayo is the simplest and most

satisfactory method of dealing with tumor, contracted lumen and obstruction of the sigmoid

At the Cincinnati General Hospital there was but one patient admitted suffering of diverticulitis with perforation in the year 1925. From 1915 to 1925, there were two patients who died of some other disease wherein diverticulæ of the sigmoid were found at autopsy. The admissions to this institution number 10,000 patients annually, of which approximately 20 per cent are referred to the surgical service.

There were 20 carcinomata recorded in the list of diseases of the sigmoid during the same period.

At another hospital with which the writer is connected there was one patient with diverticulitis and perforation and one with diverticulitis and adhesions admitted in the past five years. Frequent consideration of pathological lesions which are infrequently encountered with free interchange of ideas tends to create alertness in the recognition of such conditions and prevention of errors in the diagnosis and treatment.

THE MORTALITY IN APPENDICITIS'

BY ASTLEY P C ASHHURST, M D

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CASES of appendicitis not requiring drainage are of very little statistical interest, as nearly all such patients recover, not one in my own hands has died. But I want to put on record my statistics of complicated cases of appendicitis, though I have comparatively few to report. There are two reasons why I have so few of such cases. The first reason is that for the past ten years I have not done myself very many emergency operations for appendicitis, I have two good associates who do nearly all my emergency work. The other reason is that I have made it a rule, to which there are few exceptions, to operate *immediately* on every patient with acute appendicitis, and I am sure that in this way the number of cases requiring drainage has been kept low. Perhaps a third reason might be added, and that is the fact that fewer patients are sent into the hospital so late that complications have already developed, when I first began to operate, and was doing only emergency work, nearly every patient required drainage, whereas now my associates and I find that in a majority of emergency operations the wound may be closed.

Up to October 1, 1926, I find I have operated with my own hands on 247 patients with appendicitis so far advanced as to require drainage. (See Table.) I have divided the cases into

1 Those patients who were operated on as soon as possible after admission to the hospital

2 Those in whose cases operation was delayed because it was thought immediate operation would hasten death

247 COMPLICATED CASES OF APPENDICITIS (TO OCTOBER 1, 1926)

Operation on Admission to Hospital

	Total	Recovered	Died	Mortality Per cent
Primary abscess	98	90	8	8.1
Gangrene	44	42	2	4.5
Diffuse peritonitis	68	57	11	16.1
	<hr/> 210	<hr/> 189	<hr/> 21	<hr/> 10

Delayed Operation (Cases of Diffuse Peritonitis)

Died without operation	6	0	6	100
Abscess drained, appendix not removed	20	13	7	35
Abscess drained, appendix removed	11	11	0	
	<hr/> 37	<hr/> 24	<hr/> 13	<hr/> 35
Total	247	213	34	13.7

* Read before the Philadelphia Academy of Surgery, October 4, 1926

1 *Operation on Admission*—These cases are subdivided further by the clinical diagnoses made at the time of operation into cases of

Primary Abscess—I mean by this that the patient develops an abscess during the attack, but without having first passed through any state which can be recognized from the patient's own history or from the attending physician's report as diffuse peritonitis. The mortality in my cases is 81 per cent.

Gangrenic—By this I mean gangrene of the appendix with peritoneal contamination sufficient to require drainage of the wound, but without a walled-off abscess. The mortality in my cases is 45 per cent. I think gangrene of the appendix deserves recognition as a clinical entity apart from primary abscess. But some cases of gangrene of the appendix are accompanied by so little peritoneal soiling that no drainage is required. No such cases are included in this series. I do not believe that *perforation* of the appendix, as such, deserves recognition as a clinical entity. If the perforation occurs into preformed adhesions, the case is one of abscess or gangrene, if it does not occur into preformed adhesions, it produces *diffuse peritonitis*.

Diffuse Peritonitis—This term I use purposely because it is non-committal. It does not define how widespread the peritonitis is, because I do not know, and at operation I do not find out. All I see at the operation is the appendix and base of the cæcum, very occasionally some of the small bowel comes into view. On opening the peritoneum there is free turbid fluid spread diffusely in the abdomen, not localized by adhesions. Usually the fluid first encountered is only seropus, but sometimes it is frank pus. There is more or less inflammatory lymph on the structures which are seen, and there is pus in the pelvis or in the right flank or in both (where the cellular contents of the seropus have collected by gravity), but there are no localizing adhesions. And because no exploration is done beyond the regions mentioned, I do not know how widespread the peritonitis may be. But from the physical examination of the patient before operation, and because sometimes (after first sucking the pelvis and right flank dry and then raising the head of the table) I have been able to suck more pus out of the pelvis, I surmise that the peritonitis is *diffuse* (that is, not localized) without being *general*. By the latter term I mean peritonitis which involves all, or very nearly all, of the peritoneal cavity—not only the pelvis and both flanks, but also the regions of the spleen, liver, stomach, and beneath the diaphragm. On such patients I do not operate, because operation will only hasten death.

It is difficult to express in words any rule for determining before operation which are cases of diffuse and which of general peritonitis, each patient is a law unto himself. But usually so long as the degree of abdominal rigidity is greater than the distention, the case may be classed in the former category, and in such cases I have not postponed operation. Many cases of early diffuse peritonitis, showing only excess of turbid fluid, will not require drainage after operation. Such cases are not included in this series. The mortality in my cases of diffuse peritonitis requiring drainage is 16 per cent.

This is high, but I believe very few of the patients who died could have been saved by any other treatment

2 *Delayed Operation*—If I thought a patient admitted with peritonitis was so ill that operation on admission would surely hasten death, then operation was delayed, and the patient was treated for peritonitis by the strictest code of the Ochsner régime nothing but the stomach tube by mouth, instillation of fluids by rectum, etc., morphin. Of 37 such patients under my personal care, 6 died without operation, never reacting at all. These cases should be counted in any computation of mortality, because naturally it is the mortality of the disease, not only the operative death rate that is of interest. Twenty patients reacted so as to form one or more abscesses which could be recognized, and these abscesses were opened without attempting to remove the appendix. Of these 20 patients 7 died, a mortality of 35 per cent. Eleven patients reacted so completely that it was thought advisable to remove the appendix at the time the abscess was drained, none of these eleven patients died. So that among 37 patients considered too ill for operation on admission to the hospital, there were 13 deaths, a mortality of 35 per cent, to be compared with a mortality of 10 per cent when prompt operation was thought wise. No one can claim infallible judgment, and no doubt errors of decision occurred in some cases. This total mortality of 13.7 per cent (34 deaths among 247 complicated cases of appendicitis) is to be compared with the absence of mortality in cases of acute appendicitis without the complications of abscess, gangrene, or peritonitis. The life of every one of these 34 patients could have been saved if the family or the family's physician had insisted on immediate operation at the onset of the disease. This statement is not invalidated by the fact that many patients may have been treated at home with recovery. *to delay operation in acute appendicitis is to gamble with death*

Perhaps I should add that a very few patients, in whose cases operation was postponed because of widespread peritonitis, recovered without forming any abscess at all, these cases are not included in this series (though to do so would reduce my mortality) because at operation no cause was found for drainage, and I have no means of knowing that the patients did certainly pass through an attack of peritonitis there was *nothing* found at operation to prove the previous existence of widespread peritonitis.

Finally, may I make this remark. I think we ought to recognize that those surgeons, who advocate delay in resorting to operation, are quite likely to err by classing as *recoveries due to delay* cases in which the patients were never very seriously sick in the first place, cases, I mean, in which many surgeons (as I believe correctly) would operate promptly, and find that the wound could be closed without drainage, and there would never be any question of the patient's recovery. Only those surgeons who look inside the belly can know the true condition of affairs during the acute stages of the disease.

THE REPAIR PROCESSES IN WOUNDS OF TENDONS, AND IN TENDON GRAFTS

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HITHERTO the surgical treatment, especially after operation, of wounds involving the flexor tendons of the hand, has been attended by considerable empiricism. No attempt has been made to demonstrate by exact experimental

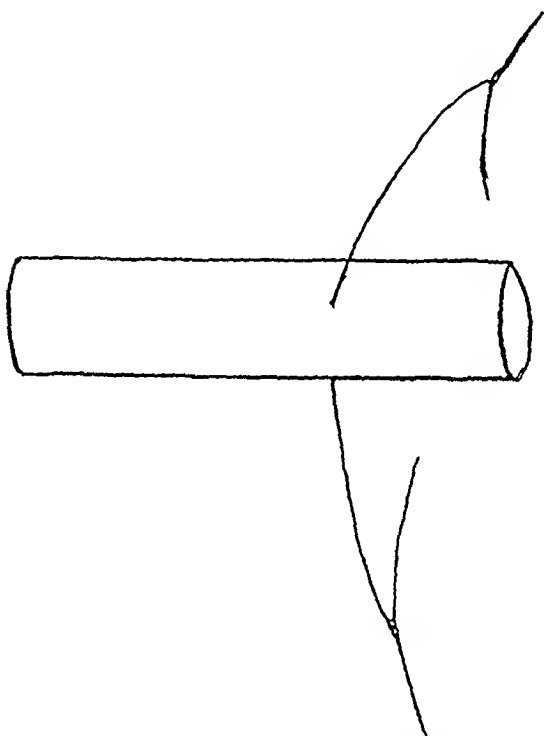


DIAGRAM 1a — *Method of Suturing Tendons* — At *a* the suture material is passed transversely through the tendon about $\frac{1}{4}$ of an inch from its extremity. Both ends of the suture are threaded on fine straight needles. One of the needles is made to pass obliquely through the tendon as shown at *b*, coming out on the opposite side. The other needle is passed through in similar manner, coming out at the opposite side of the point of exit of the first needle. This is shown at *c*. The needles are then passed again obliquely through the tendon and made to come out at the end as indicated at *d*. The only points of the suture material which lie on the surface of the tendon are indicated at *A*. Figures *e* and *f* indicate the anterior and posterior aspects of the tendon showing the amount of suture material visible on the surface. When the knots are tied uniting the proximal and distal extremities of the divided tendon, it will be seen that they lie buried between the tendon ends. They should be tied in such a way as to cause 'buckling' of the tendon at the site of repair. The same technique is used for an insertion of a free tendon graft with the exception that four sutures are placed instead of two.

methods, the reasons for the various procedures that have been used. For instance, no one has as yet thrown definite light on the question as to when it is safe to institute motion following tenorrhaphy. Then again, it has been asserted in various quarters that something unusual occurs at the site of tenorrhaphy between the sixth and ninth days after operation, which jeopardizes the suture line, making any form of motion during this period inadvisable. Among other things, a study of this kind involves a consideration of the processes of repair attending the operations of tenorrhaphy and free tendon grafting. The following study was therefore undertaken with a view of determining the rationale of various operative and post-operative procedures and of ascertaining a clear conception of the repair processes.

Great difficulties were encountered in the early part of the work in obtaining adequate tendon tissues to work with. The best experimental animal in a study of this kind is the monkey, because the structures are practically identical with those

found in the human being. Because of the number of animals necessary, utilization of this animal, of course, became impossible. Rabbits were

TENDON REPAIR

next used, but it was soon found that the tendon structures were too small and that the animals did not lend themselves easily to the prolonged immobilization of an extremity in a plaster cast. It was finally decided to use dogs. This animal does not present any tendon structure similar to that found in the flexor tendon of the hand, *i.e.*, the epitenon variety where the tendon glides freely in an encircling sheath. The type of tendon mechanism nearly approaching that found in the human is that seen in the anterior tibial group. These tendons, in addition to an enclosing sheath, have a mesotenon which is attached to the deep surface of the tendon and which contains the nutrient blood-vessels.

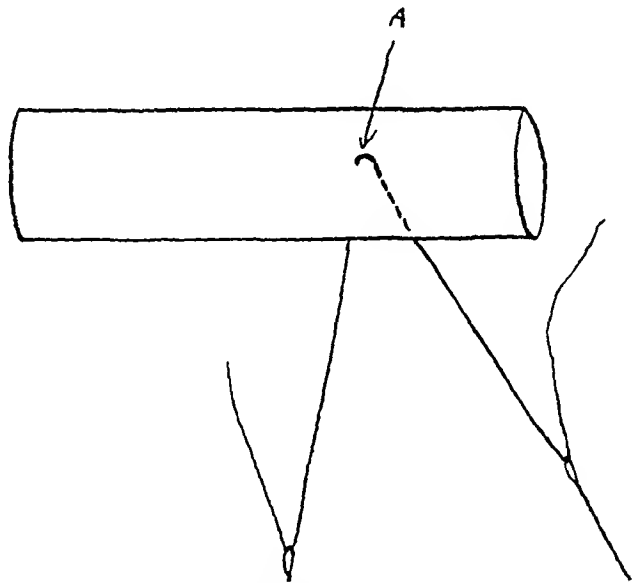


DIAGRAM 1b —See legend under Diagram 1a

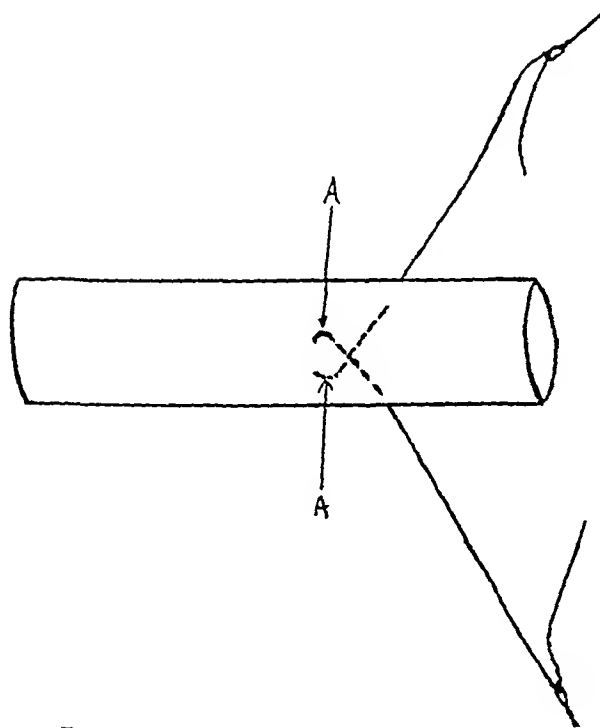


DIAGRAM 1c —See legend under Diagram 1a

In general, the type of operation was made as simple as possible and to approach as nearly as possible the procedure used in the human. After thorough shaving and cleansing of the skin of one hind leg, the operative field was carefully prepared and an incision made anteriorly so as to expose the anterior tibial group of tendons. Making use of an atraumatic technic, the sheath was divided and the tendons isolated. In order to simulate as closely as possible the anatomy of the flexor tendon in the human, the tendon was separated from its mesotenon. Then two varieties of experiment were done. In the first, the tendons were divided and then resutured, according to the technic described in the protocols (see Diagram 1), the tendon sheath was then carefully repaired, the subcutaneous tissues were approximated and the skin sutured. A light plaster cast was applied with the ankle, knee, and hip-joints in acute flexion. At varying times, starting with the second and third post-operative days, the casts were cut down and passive motion instituted. This was done daily until a period when the cast was entirely dispensed with, varying from the fifth to the eighteenth day after operation.

In the second type of experiment, the same technic was employed in exposing the tendons. A portion of tendon, measuring about 2 cm in length, was excised from the left hind leg and a free tendon graft, taken from the right hind leg, was inserted into the deficiency, employing the

technic to be described later (See Diagram 1) The parts were immobilized and the same after-care instituted. At varying times, following the removal of the cast, the animals

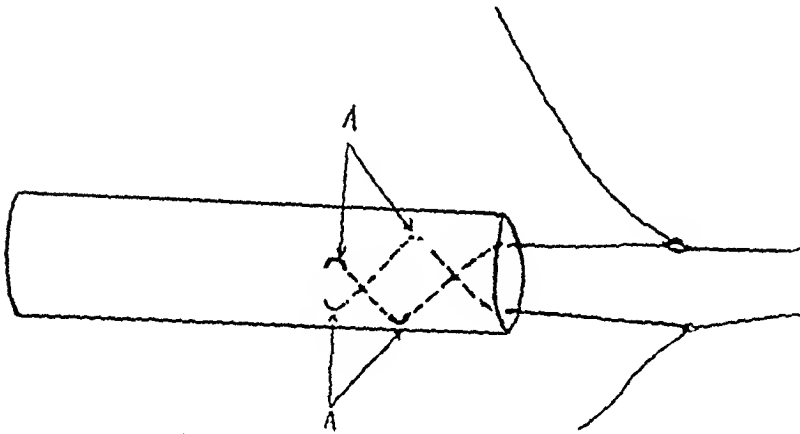


Diagram 1d—See legend under Diagram 1a

were again anesthetized and the repaired tendons were removed for microscopic study. The gross findings at the second operation were carefully noted.

PROTOCOLS

Experiment

No. 1 Dog No. 8146—The left hind leg was carefully shaved with soap and water followed by thorough cleansing with benzine, alcohol and ether. It

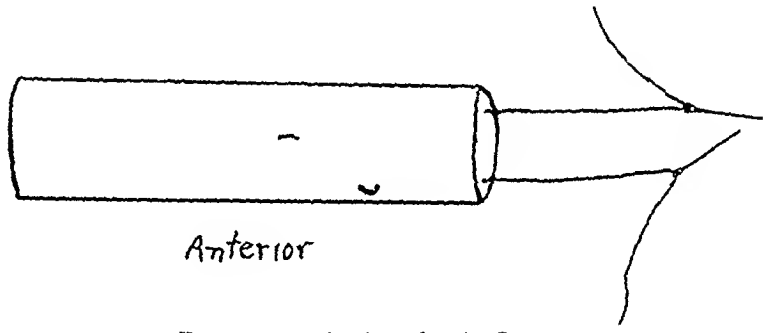


Diagram 1e—See legend under Diagram 1a

was then painted with 3½ per cent iodine. Longitudinal incision was made over the anterior aspect of the leg; all bleeding points carefully ligated. The tibialis anticus group of tendons was isolated after making a small longitudinal incision in the tendon

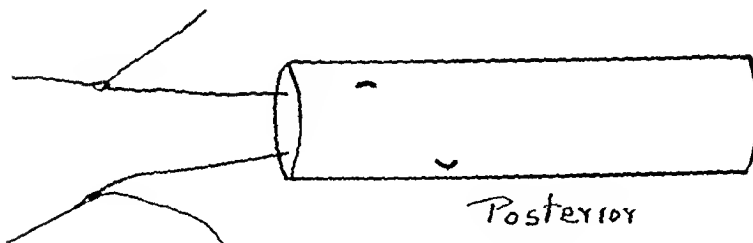


Diagram 1f—See legend under Diagram 1a

sheath. The mesotenon was separated from the posterior aspect of the tendon. The tendon was then divided transversely with a razor blade. Sutures consisting of fine silk on fine straight needles were

then inserted in the proximal and distal stumps according to the Bunnell technic. The four strings of silk were then tied together so as to bury the knots between the tendon ends. The anterior annular ligament of the ankle-joint, a definite thickened structure in the dog, was left intact. The tendon sheath was repaired with interrupted stitches of fine catgut. The skin and subcutaneous tissues were sutured with a continuous stitch of silk. A plaster case was then applied with ankle, knee and hip-joints in flexion. On the seventh post-operative day, the cast was cut down and passive motion instituted in the ankle and

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knee-joints The range of motion was gradually increased The case was removed on the tenth post-operative day The wound had healed per primam On the twenty-sixth post-operative day, the dog was again anesthetized and the wound reopened It was found that the repaired tendon was adherent to the tendon sheath at the site of suture There was no gross evidence of the silk sutures The tendon, however, separated easily from the tendon sheath The specimen was excised for microscopic study

Experiment No 2 Dog No 8158—The identical procedure was used here, as in Experiment No 1 The case was removed on the seventh post-operative day and the



FIG 1—Section of specimen removed in Experiment No 1 Simple tenorrhaphy using silk which is shown at A The scar between the tendon ends is indicated at B Note the vascular connective tissue encircling the tendon at this point There is no evidence of the knots between the tendon ends

wound was reopened on the ninth post-operative day At this time, it was found that the suture line was intact, and there were numerous adhesions between the tendon sheath and the proximal part of the tendon The specimen was excised for study

Experiment No 3 Dog No 8166—The same technic was again used The plaster case was loosely applied, allowing a moderate range of motion from the very beginning The case was removed on the sixth post-operative day and the wound was reopened on the eleventh post-operative day It was found that the sutured tendon



FIG 2—Simple tenorrhaphy with removal of the immobilizing case on the seventh post-operative day The line of suture is shown at A The suture material is visible at B Note the beginning replacement of the scar tissue by the specialized formed connective tissue of the tendon at this early date

had pulled apart with the silk sutures stretching between the divided ends There were numerous adhesions between the tendon stump and the tendon sheath This experiment, supported by three or four others with similar results, proves the inadvisability of allowing active motion from the first post-operative day

Experiment No 4 Dog No 8213—The same operative procedure was instituted in this case The case was applied in the usual manner Passive motion was instituted on the fourth post-operative day The case was removed on the twelfth post-operative day On the twenty-eighth day the wound was reopened and it was found that the tendon was intact but somewhat thinned out The specimen was excised for study

Experiment No 5 Dog No 8334—The same technic was again used Passive

motion was not instituted until the case was removed on the seventh post-operative day, on which date the wound was found firmly healed. On the twenty-third day, the wound was reopened and the tendon was found intact. It was bulbous at the suture line and adherent at this point to the tendon sheath. The specimen was excised for study.

Experiment No 6 Dog No 8366—The same technic was used with the exception that the mesotenon was not divided. Motion was started on the ninth post operative day when the case was removed. The wound was reopened in three weeks, and it was found that the suture line was intact, but that the tendon was moderately adherent throughout its length.

Experiment No 7 Dog No 8382—The same technic was used as in the former



FIG. 3.—Simple tenorrhaphy, passive motion instituted on the fourth post operative day, case removed on the twelfth day, specimen excised on the twenty-eighth day. Suture material visible at A and A'. The point of tenorrhaphy visible at B. Note the stretching of the tendon and scar at this point with minimum scar tissue between tendon and sheath. The stretching is probably due to early motion.

experiment with the exception that the tendon was divided at a point distal to the annular ligament. No motion was allowed until the ninth day, when the case was removed. The wound was reopened on the twenty-first day, and it was found that the point of suture was bulbous and adherent to the sheath. The specimen was excised.

Experiment No 8 Dog No 8383—The same procedure was used as in the preceding experiment. No motion was allowed until the ninth day, when the case was removed. The wound was reopened on the nineteenth day, but the tendon was found firmly adherent to the tendon sheath at the point of suture. The specimen was excised.

Experiment No 9 Dog No 8389—The same procedure followed. The case was removed on the eighth day. The wound was reopened on the sixteenth day. It was then found that union was firm, and the tendon was only very lightly adherent to the sheath at the point of suture. The specimen was excised.

Experiment No 10 Dog No 8402—The same technic as in the preceding experiment. No motion was allowed until the tenth day, when the case was removed. The wound was reopened on the nineteenth day, and it was found that the tendon was firmly

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united with moderate adhesions between the sheath and tendon and evidence of fatty degeneration of the muscle belly of the tibialis anticus. The specimen was excised.

Experiment No 11—Dog No 8468—Both hind legs were prepared as described in the preceding experiments. Both anterior tibial tendons were isolated in the same manner, using a careful atraumatic technic. On the left side, a piece of tendon, measuring 2 cm in length, was removed after separating off the mesotenon. Making use of the principle of Mayer, namely, that, when the origin and insertion of a muscle are approximated as close together as possible, the tension of the tendon should be zero, the origin and insertion of the tibialis anticus were approximated by flexing the various



FIG 4—Simple tenorrhaphy using silk sutures with removal of cast on the seventh post-operative day. Specimen was excised on the twenty-third day. The sutures are visible at A. Note the dense scar tissue at the site of union B. The relative absence of connective tissue on the surface of the tendon is noteworthy.

joints and the distance between the divided ends measured with calipers. A free tendon graft of the same length as the deficiency just measured was then taken from the right tibial tendon and placed in the defect on the left side, making use of fine silk inserted according to the method of Bunnell. The tendon sheath was then sutured with inter-



FIG 5—Simple tenorrhaphy with the tendon divided at a point distal to the anterior annular ligament. The case was removed on the ninth day. The specimen was excised on the twenty-first day. The vacuolization noted at A marks the site of a suture inserted at the proximal stump. Note the firmness of repair and the replacement of the scar tissue by formed connective tissue. The adhesions along the surface of the tendon B, are well-developed.

rupted stitches of plain catgut. The wound was closed and a plaster case applied as previously described. On the eleventh post-operative day, the cast was removed and the animal allowed to run about. On the eighteenth post-operative day, the wound was reopened and it was found that there was no infection. One silk suture in the region of the graft had become loosened. The sheath was markedly thickened. The graft was intact and firmly united, and it was adherent to the tendon sheath. The specimen was excised for study.

Experiment No 12 Dog No 8482—The same procedure as described in Experiment No 11 was repeated in this animal. The case was removed on the ninth day,

and the wound was reopened on the fourteenth day. It was found that the distal end of the graft had separated from the distal end of the divided tendon. The proximal end of the graft had become united but four-fifths of the graft had degenerated.

Experiment No. 13 Dog No. 8491.—The same procedure was followed in this case as in the preceding two experiments. The plaster case was removed on the ninth post-operative day and active motion allowed. The wound was reopened on the fourteenth day, and it was found that the graft had become firmly united with light adhesions between it and the tendon sheath. Suture material was not visible. The specimen was excised for examination.

NOTE.—Numerous similar experiments were performed as described in the preceding three. The period of immobilization varied from the eighth to the twentieth days.



FIG. 6.—Simple tenorrhaphy, no motion was allowed until the twelfth day. The specimen was excised on the nineteenth post-operative day. Note the extensive adhesions on the surface of the tendon at A, due to the prolonged immobilization. The trauma caused by removal of the specimen is visible at B.

Specimens were excised from the twelfth to the thirty-first day post-operative for microscopic study.

Repair Processes. Simple Tenorrhaphy.—From an examination of the microscopic sections, obtained during these various experiments, it appears evident that a scar forms, as elsewhere in the body, between the divided ends of the tendon. The component elements at the initial stage are composed of fibrin probably from both coagulated blood and the synovial fluid found in the tendon sheath. In addition to these elements there are seen also the various types of blood-cells. With the suture remaining intact young fibroblasts and fibrils grow out from the proximal and distal ends of the tendon and probably from the sides of the injured tendon sheath, along the network of fibrin. This, with the outgrowth of small capillaries and the accumulation of a small number of mononuclear leucocytes constitutes the young scar. During the first three days following the tenorrhaphy, this scar cannot withstand stress and strain. The intact suture is the restraining factor in the prevention of stretching and separation of the tendon ends. After the fourth day examination of the sections showed that the suture material swells and the knots between the tendons have a tendency to loosen. It is after this period that the scar tissue of itself becomes the bulwark in the maintenance of the continuity of the tendon. With stress and strain applied on the fifth

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day, in the form of passive motion (in experimental animals only), it appears from the sections that the scar joining the tendon ends stretches somewhat, but not to any marked degree. This presupposes that the motion employed is not extensive at the beginning. Following this day the institution of active motion in these animals, which occurred when the plaster casts were removed, showed that the scar was capable of withstanding a considerable amount of strain without any evidence of stretching or separation provided the wound was clean.

Some observers have reported that, in a tenorrhaphy, something occurs at the point of suture between the sixth and the ninth days post-operative,



FIG 7—Simple tenorrhaphy, cast removed on the eighth day. Specimen excised on the sixteenth day. The suture material is visible at A. The firm union and the lack of any marked adhesions, is noteworthy.

which causes a weakening in the scar. They have therefore cautioned against any form of motion during this critical period. The experiments reported in this paper do not bear out this contention. On the contrary, it appears that, following the fifth day, the scar tissue between the divided ends of the tendon progressively increases in strength and density up to the day when the union is as firm as it ever will be.

In the specimens removed at about the twenty-eighth day, it was found difficult to determine in the gross exactly the point of suture, except for the presence of adhesions to the tendon sheath. This was further emphasized in the microscopic sections which seemed to show that the specialized formed connective tissue of which tendon is composed, entirely replaces the scar tissue, first visible between the tendon ends. The sections disclose an almost unbroken line from the proximal to the distal segments.

In the early stages of repair, the suture material is visible microscopically between the tendon ends. About the seventh or eighth day, following the period when swelling occurs in the suture material, the knots between the tendon ends begin to disintegrate. As early as the fourteenth post-operative day, sections fail to reveal the knots between the tendon ends. However, that

part of the suture material which is placed in the body of the tendon proper, remains and is visible in every section made in the experiments reported in this paper. It is probable that this portion of the suture remains unchanged for an indefinite period.

It is interesting to note the various changes that occur at the site of union between the tendon and the sheath, from the day of operation to the time when the repaired tendon has returned to practically a normal state. The train of events, pieced together from the various microscopic sections, seems to be as follows. No matter how carefully one conducts his operative technic, there is considerable trauma at the site of tenorrhaphy both on the surface of the tendon and its surrounding sheath. This trauma may only

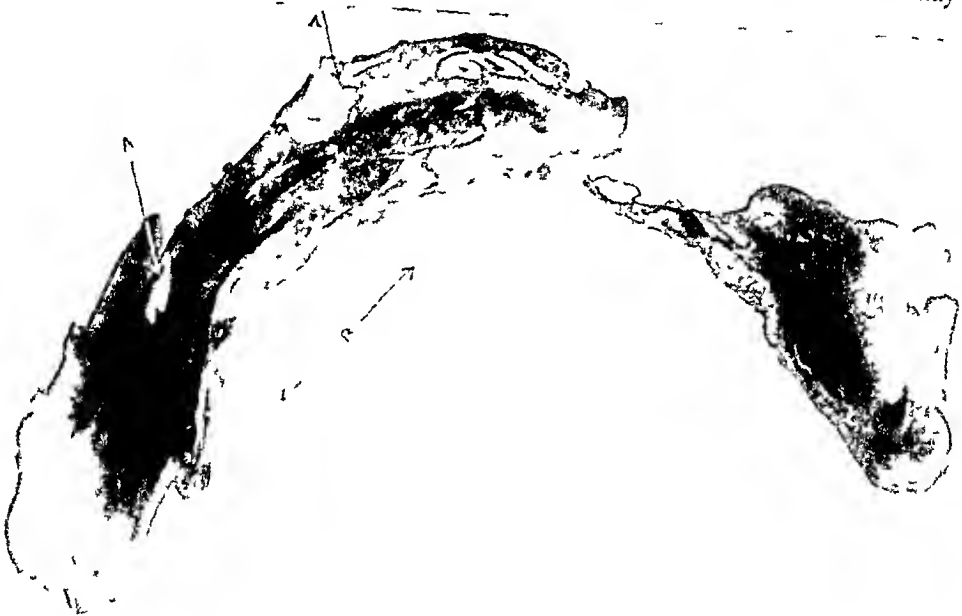


FIG. 8.—Simple tenorrhaphy, motion not started until the tenth day when the case was dispensed with. Suture material visible at *A*. The site of tenorrhaphy visible at *B*.

be microscopic, but enough to cause the rubbing off of the endothelial cells lining the tendon sheath and the surface of the tendon. Following this trauma, the tendon becomes adherent to the tendon sheath. During the period of immobilization, young fibroblasts grow outward from the subendothelial tissues of the sheath and from the tendon itself and more firmly unite the two structures. Following the institution of motion, the contraction of the muscle belly controlling the tendon causes periodic stretching of this early scar between the tendon and its sheath. As time goes on and the muscle contractions become more pronounced, the stretching is more accentuated. This causes an elongation of the various connective-tissue cells joining the tendon and sheath, until finally they break at the point of maximum tension, usually at the branched extremities of the cells. With the constant to and fro gliding mechanism, the cells now lining the surface of the tendon and the tendon sheath, show a gradual adaptation to their new function and assume the microscopic appearance of the flat endothelial cells lining the normal tendon and sheath. Both in these experiments and clinically, in two

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cases of flexor tenorrhaphy which were operated upon a second time for a new lesion, it was impossible to demonstrate the exact point of suture, there being no evidence of adhesions between tendon and sheath

Tendon Grafts—The main inquiry in the study of the repair processes involved in free tendon grafts is centered about the question of whether the graft lives as such, or forms a bridge, as in bone grafts, along which cells grow from the proximal and distal ends of the repaired tendon. The experiments reported in this paper show definitely that the graft lives as such and that the repair proceeds along the same lines as described in the preceding section. Of course, there are numerous biochemical and biophysical phenomena

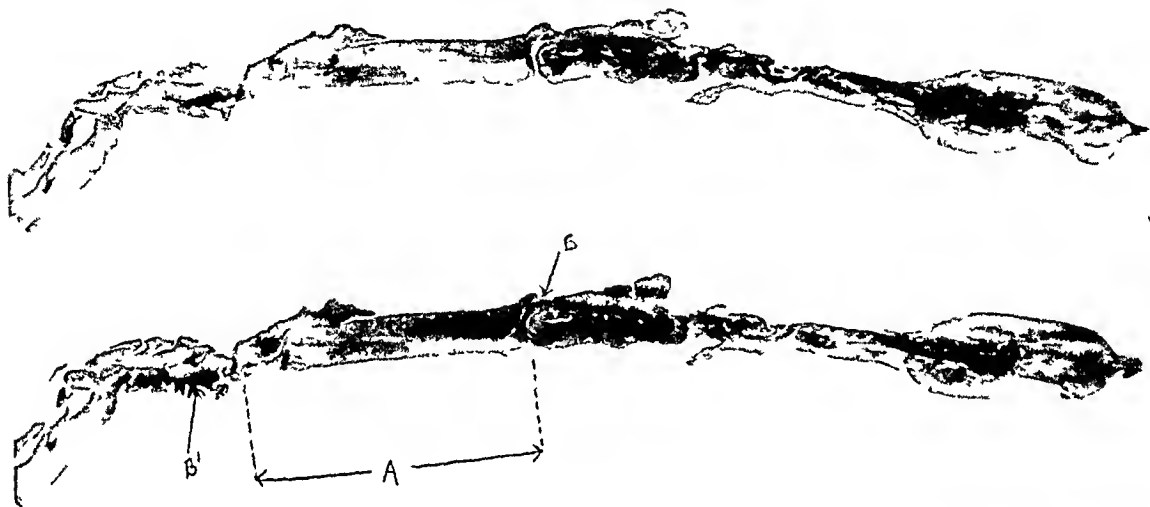


FIG 9—Free tendon graft in a rabbit. The animal was found dead in its cage on the tenth post-operative day, on which date the specimen was excised. In the gross, the tendon appeared viable, with the suture lines intact. The above section shows the graft at A with the suture material visible at B and B'. High power examination shows that there is complete disintegration of the cells composing the graft.

involved here, the exact nature of which can be explained only by conjecture. It is probable that the graft derives considerable nutrition from the tissue juices, whether they be derived from the endothelial lining of the sheath or the surrounding connective tissue. Just what amount of nutrition is derived from these sources, it is difficult to say. In any event, the graft soon becomes united by scar tissue to the proximal and distal ends of the tendon and also to the enclosing sheath. It is probable that the main source of nutrition is derived from the outgrowth of young capillaries and lymph-vessels from the tendon ends and from the subendothelial tissues of the sheath.

In the initial five or six days, a certain amount of swelling occurs in the graft which, microscopically, shows it to be caused by an increase in size of its component cells. The nuclei are not as definitely outlined as in the normal tendon and stain irregularly. Following this period, the swelling subsides and the cells assume a normal appearance. By this time, there has been a practically complete outgrowth of capillaries, assuring the nutrition of the graft. Following the seventh or eighth days, the repair proceeds in exactly the same manner as in simple tenorrhaphy with the exception that there are two scars to be considered and an area of union between tendon

and sheath stretching for a distance corresponding to a little more than the length of the graft itself. The separation of the tendon from its surrounding sheath apparently follows the same process as described in the preceding section.

In the cases of both tenorrhaphy and tendon graft, the immobilization produced in all the animals some degree of atrophy of the muscle bellies controlling the tendons. It varied from a slight atrophy of the muscle characterized by an increase in fibrous tissue, to a marked fat replacement, visible in the gross.

Discussion—It appears from the preceding description and an examination of the various sections made during these experiments, that very definite



FIG. 10.—Free tendon graft. Motion was instituted on the eleventh post-operative day. The wound on the eighteenth day and the specimen excised. The graft was found to be intact and to the tendon sheath. The suture material is visible at A. Note the union of the graftment of the tendon at B. Proximal segment of the tendon is visible at C. Adhesions are noted at D.

data have been obtained, which can be used to advantage clinically. In the first place, it is felt that definite information has been obtained regarding the time when motion can be started following a tenorrhaphy. Providing the wound is clean, it is reasonable to assert that *active* motion within the limits of pain can be instituted on the fifth post-operative day. It is felt that it would be dangerous to employ *passive* motion in this type of case sooner than the fifteenth or sixteenth post-operative day, because it is impossible for the surgeon to gauge the amount of tension he is applying at the site of repair, commensurate with the strength of the scar tissue joining the tendon ends. Active motion, however, is safe when carried out within the limits of pain, because the patient is able to gauge accurately the amount of strain he is placing on the suture line by the pain produced when the tendon pulls away from its loosely adherent sheath.

The whole object in instituting early motion following a tenorrhaphy is to prevent the formation of firm adhesions between the tendon and its sheath. It is felt that following the fifth day, the carrying out of daily active motion for a period of ten to twenty minutes, under the direct supervision of the surgeon himself, will give the greatest opportunity for a return of the tendon to its normal state. It is also felt that between these periods of exercise, a proper retentive apparatus should be worn by the patient which will place the suture line under least tension. In this connection, the experiments seem to show that union is firm enough about the eighteenth day to allow for the discontinuance of the retentive apparatus.

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The data obtained regarding free tendon grafts indicate that it is safe to institute active motion about the tenth post-operative day, maintaining the retention apparatus during the periods of inactivity. It also seems that it is unwise to remove this apparatus until about the twenty-fifth day, post-operative.

It is unnecessary in this paper to enlarge upon any other form of therapeutic remedy such as light massage, radiant heat, etc., because they have proved to have definite value in the post-operative care of these cases (See *ANNALS OF SURGERY*, vol lxxxI, 1925, p III)

CONCLUSIONS

- 1 After the operation of tenorrhaphy, using the technic outlined in this



FIG 11 —Free tendon graft. Motion was started on the ninth post-operative day and the wound reopened on the sixteenth day. In the gross the graft was found to be firmly united, but with light adhesions between it and the sheath. The section shows the suture material in the graft itself at A and in the proximal and distal ends of the tendon at A'. Note the firm union between these points and the viability of the cellular structures of the graft. The lack of adhesions is noteworthy.

paper and previous publications, repair of the tendon proceeds along definite lines both as regards the time element and the gross and histological pictures.

- 2 It is safe to institute active motion on the fifth post-operative day and to remove the retentive apparatus on the eighteenth post-operative day, after which the repair will have proceeded to a point where the scar can withstand considerable stress and strain.

- 3 Free tendon grafts, inserted to bridge a defect in a tendon, live as such.

- 4 It is safe to institute active motion after the insertion of a free tendon graft on about the tenth post-operative day and to dispense with the retention apparatus on about the twenty-fifth day.

- 5 The return of function following a tenorrhaphy, or the insertion of a free tendon graft, is dependent upon an intact suture line, a return of its muscle belly to a normal state and the breaking away of the tendon from its surrounding tendon sheath. The latter of these three factors is the most important and the final outcome may not be evident until a period of three or four months has elapsed.

THE DANGER OF INFECTION ABOUT THE FACE

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THE complications which small furuncles around the upper lip and nares may produce are not generally recognized. In active hospital services one sees one or two deaths yearly from maltreated face infections. The fatalities do not result from medical procrastination, but from overzealous surgical intervention. It is essential to have a clear conception of the mode of spread of infection about the face before intelligent treatment can be instituted. The danger of the infection is producing a thrombophlebitis of the facial vein, with a resulting cavernous sinus thrombosis. Thrombosis of the cavernous sinus is nearly always fatal. Figure 1 shows the distribution of the venous blood supply about the face, and one sees a direct connection from the facial vein to the cavernous sinus. There is one area marked in heavy outline about the upper lip and nares which is the critical area of face infections. According to Dixon,¹ the factors which produce serious complications in this locality are four. First, early and frequent trauma. Second, absence of subcutaneous fat on the upper lip. Third, active muscular supply of this region. Fourth, the inability of the veins that drain this region to collapse. The most important factor seems to be the rich venous plexus, both superior and deep in relation to the muscles of the upper lip. Trauma causes the thrombus to be spread to the facial veins with resulting cavernous sinus thrombosis in a high per cent of cases. The danger zone of infection about the face can be roughly outlined as the area between the hair line of the forehead above and the chin below, with two parallel lines connecting this area at the outer wall of the orbit on each side. As can be seen in Fig 1, all of this area has a venous drainage connecting with the cavernous sinus. To get a clear conception of the venous return of the face, I will quote from Gray:² "There are some points about the facial vein which render it of great importance in surgery. It is not so flaccid as are most superficial veins, and, in consequence of this remains more patent when divided. It has, moreover, no valves. It communicates freely with the intracranial circulation, not only at its commencement by its tributaries, the angular and supraorbital veins, communicating with the ophthalmic vein, a tributary of the cavernous sinus, but also by its deep tributaries, which communicate through the pterygoid plexus with the cavernous sinus by tributaries which pass through the foramen ovals and foramen lacerum medium. These facts have an important bearing upon the surgery of some diseases of the face, for on account of its patency the facial vein favors septic absorption, and therefore any phlegmonous inflammation of the face following a poisoned wound is liable to set up thrombosis in the facial vein, and detached portions of the clot may give rise to purulent foci

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in other parts of the body. On account of its communications with the cerebral sinuses, these thrombi are apt to extend upward into them and so induce a fatal issue."

The Treatment—Furuncles about the danger zone of the face should not be traumatized by squeezing or small incisions. Needless to say numerous

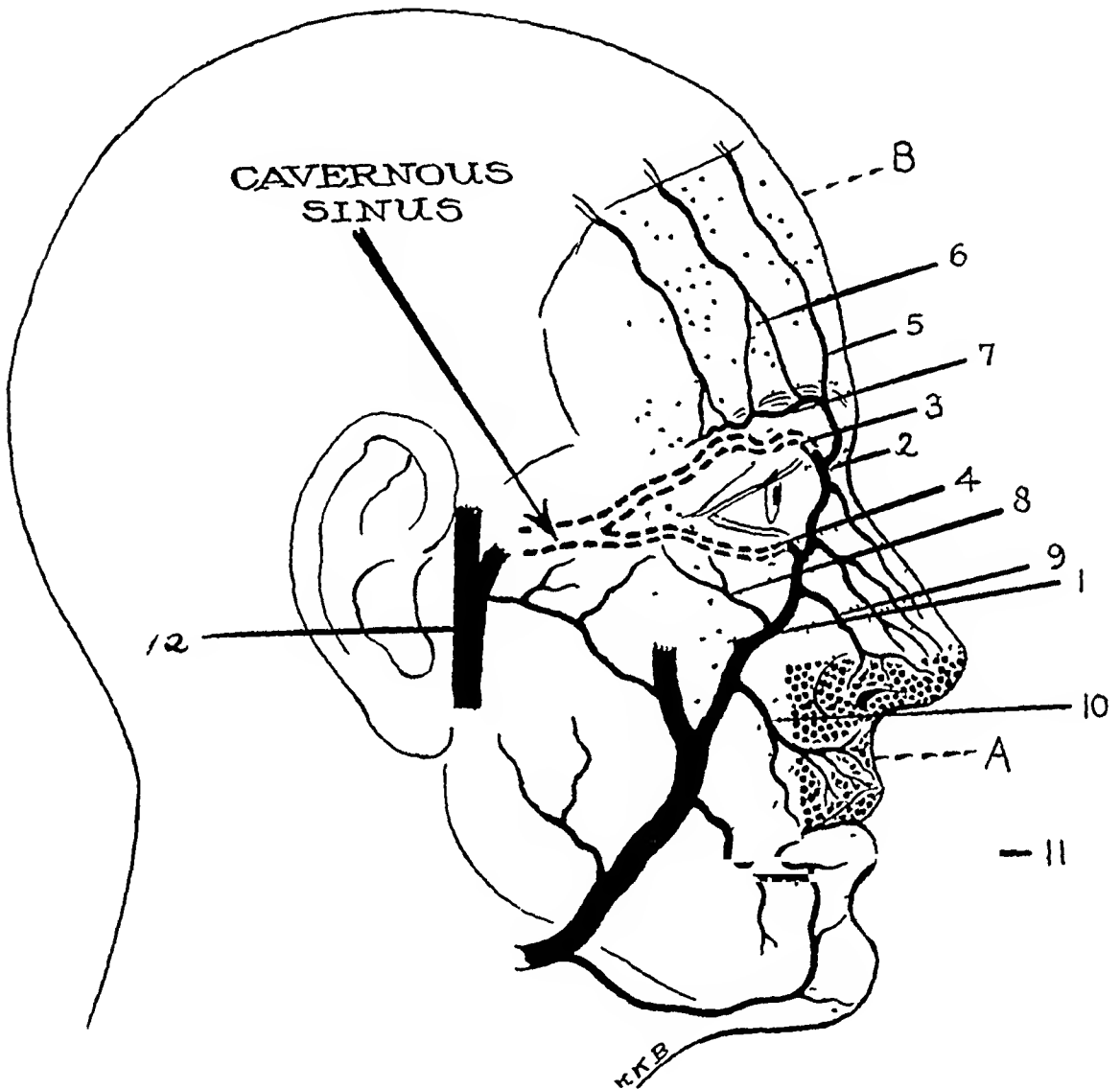


FIG 1—1 Anterior facial vein 2 Angular vein 3 Superior ophthalmic vein 4 Inferior ophthalmic vein 5 Frontal vein 6 Supraorbital vein 7 Superior palpebral vein 8 Inferior palpebral vein 9 Nasal vein 10 Superior labial vein 11 Inferior labial vein 12 Temporal vein A Heavy dotted area around nose and upper lip is the critical area of face infections B Light dotted area is the danger zone for face infections

furuncles about the face never lead to serious complications, but in those in which thrombosis of the cavernous sinus occur, the prognosis is fatal. Martin² states that every furuncle of the face and nose, and especially the upper lip, should be treated as if it might become a dangerous disease. It is best to treat all face infections conservatively. Heat is best used in the form of flaxseed poultices. This seems preferable to wet dressings. If the patient has chemosis, hot boric compresses may be applied to the eyes. The infection will usually localize with conservative treatment, and frequently will spontaneously perforate through the skin or mucous membrane, after which the

slough will be discharged through the opening. If the infection does not localize, an incision with a very sharp scalpel should be made, under general anesthesia, without traumatizing the area. The wound should not be packed with gauze, but a rubber diaphragm to hold the edges apart is all that is necessary. Hot poultices should be applied after the incision has been made. If the infection leads to a cavernous sinus thrombosis with meningitis, the only treatment that can be rendered is supportive measures.

CONCLUSIONS

1 Infections about the upper lip and nares will lead to cavernous sinus thrombosis in a certain per cent of instances.

2 Trauma should be avoided in the beginning infection, particularly small incisions.

REFERENCES

- ¹ DIXON O. Jason. The Pathologic Examination in Cavernous Sinus Thrombosis. Jour A M A, October 2, 1926
- ² MARTIN. ANNALS OF SURGERY, July, 1922, vol LXVI, No 1
- ³ GRAY'S Anatomy. Eighteenth Edition

ADENOMA OF THE THYROID¹

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MUCH has been written during the past few years on the subject of adenoma of the thyroid in reference to its geographical distribution, symptomatology and treatment. The latter heading including prophylaxis, operative indications and technic, and recently the dangers from iodine therapy as in the excellent papers by Jackson¹ and others. The aspects of form and function seem to me to have escaped due discussion, certain terms and considerations, particularly in respect to form having persisted for many years.

In respect to form, there are first of all the two main types, the diffuse adenomatosis, described by Goetsch² and Else,³ and the circumscribed, with single or multiple encapsulated masses. The encapsulated adenomata, possessing distinct vagaries as to form, have been classified as fetal or adult, colloid or cystic or calcified. A difference in time of onset of growth, having been ascribed as the cause whether a given mass were fetal or adult, an undue emphasis has been placed upon this detail. Similarly, whether or not a cyst were present, seems to have occupied the minds of many clinicians as of more importance than the fact that the patient possessed an adenoma of the thyroid.

Else discusses the origin of the diffuse adenomatosis from the so-called interstitial cells of Wolfler, but his arguments apply equally well to the same origin for the localized form. In the discussion of his paper on the relationship between the pathologic and clinical aspects of the diseases of the thyroid gland before the Section on Surgery, New York Academy of Medicine, Falk⁴ stated that he had made reconstructions of glands with special attention to these interstitial cells and he found them to be separate and distinct groups not participating in the formation of an acinus, and by the same token not a few cells from the wall of an acinus lying in adjoining serial sections. Considering these cells as embryonic cells, robbed as it were of their birthright to participate in the normal development of an adult thyroid gland, we may predicate a development of them similar to what might be called the natural history of the cells in the normally developing gland.

Briefly, the embryology of the thyroid gland is as follows. Starting from the median anlage in the anterior wall of the primitive pharynx, and from the two lateral anlage in the fourth clefts, there occurs a downward growth from the former, and a forward growth from the two lateral ones to an eventual fusion, usually with obliteration of the median stalk, resulting in the two lateral lobes joined across the midline by the isthmus of the

¹ Read before the New York Surgical Society, December 8, 1926

adult thyroid gland, a pyramidal lobe or thyroglossal cyst representing imperfect obliteration of the median stalk. The cells at first are grouped

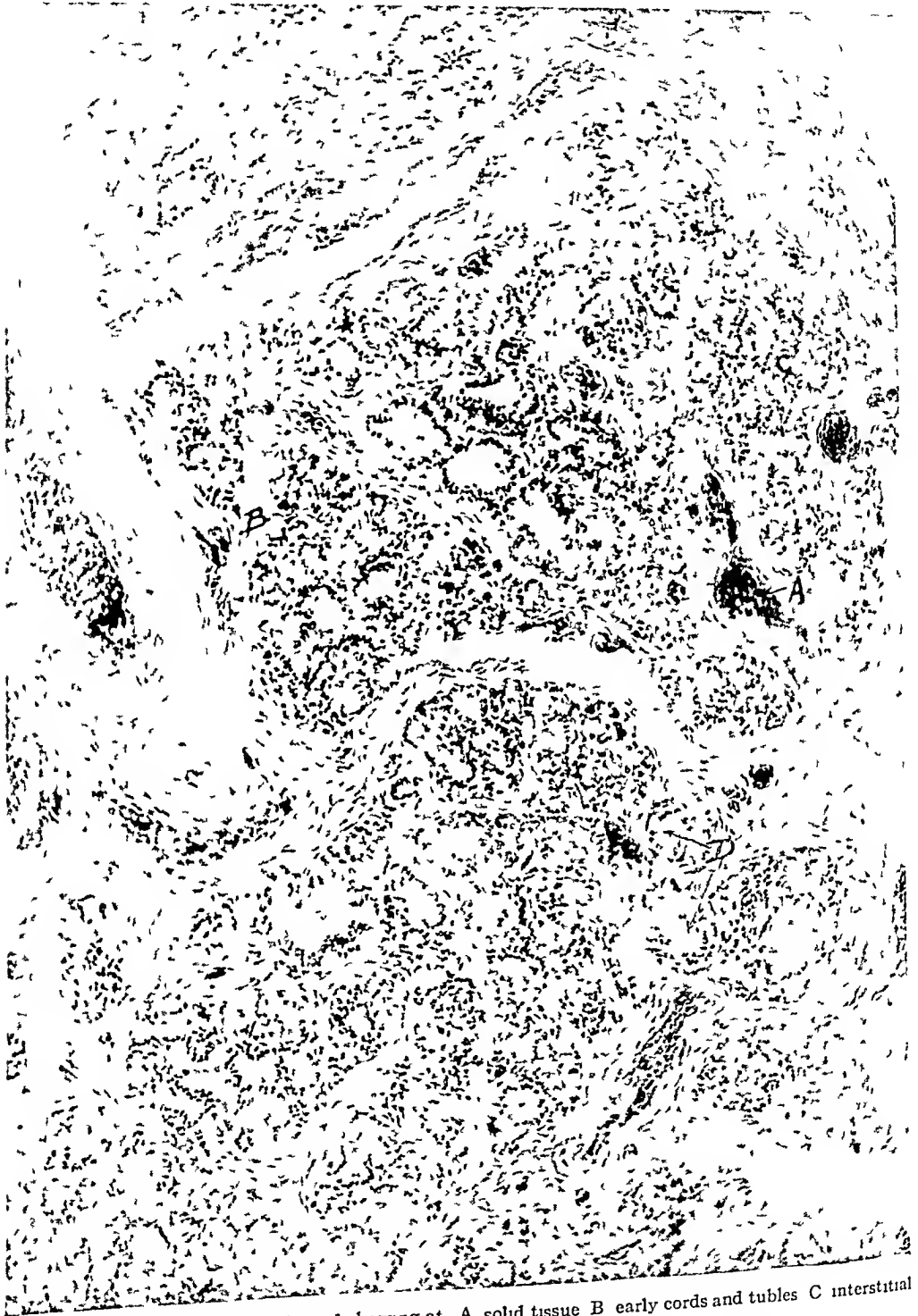


FIG 1—Seven months fetal thyroid showing at A solid tissue B early cords and tubules C interstitial cells, D small acini and colloid

in a solid homogeneous mass. Later with the appearance of connective tissue and blood-vessels, solid cords are formed, cross-sections of which show a circular arrangement of the cells. These cords then obtain a small lumen, so that a distinct tubular formation is present. The tubules apparently are

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cut off at many points by connective tissue, and with the accumulation of colloid the adult acinar arrangement is finally obtained. A section of a seven months' fetal gland (Fig 1) will show all of these stages, solid tissue, cords, tubules, small acini containing colloid, and here and there undifferentiated interstitial cells.

The same natural history, did it obtain in the growth of the interstitial cells, would give us tissue of different types, depending upon the stage of development or relative age of the adenoma. This seems to us the reason

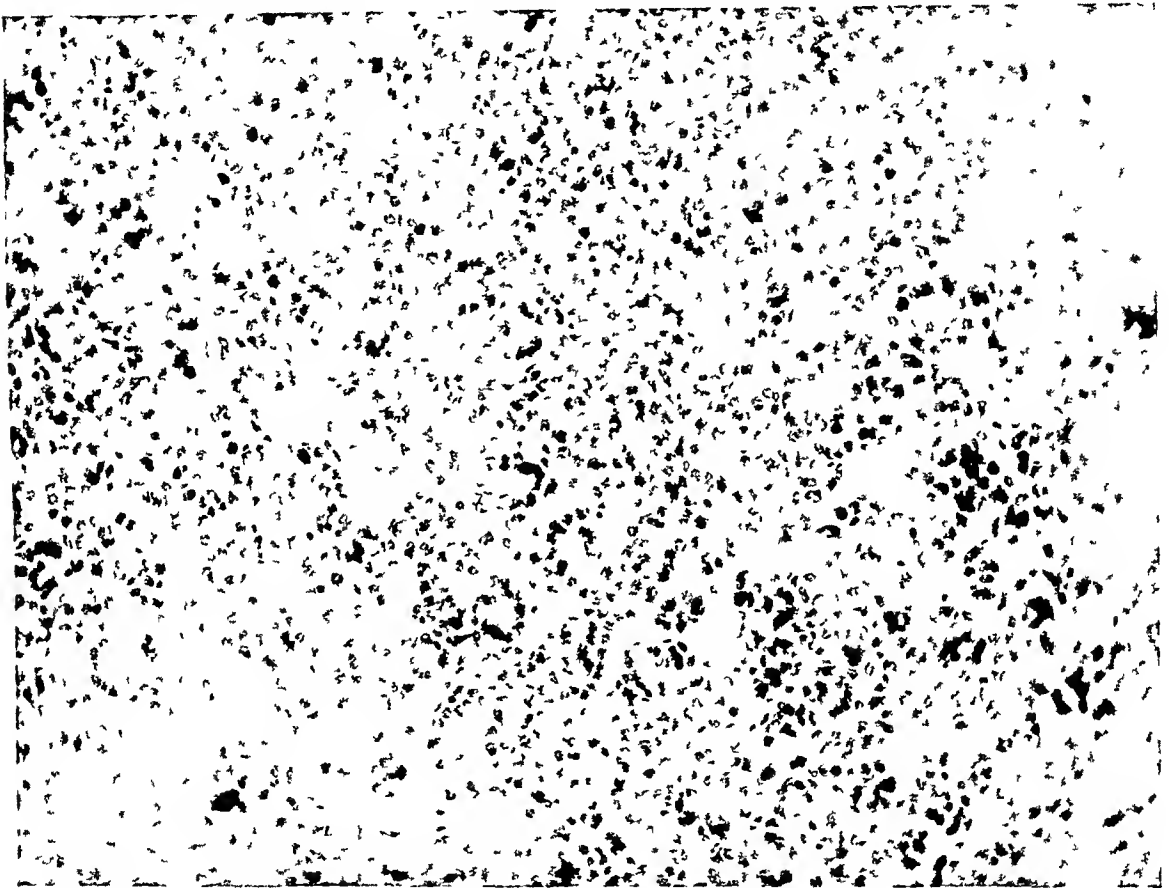


FIG 2 —Adenoma composed of small tubules

why such differences occur in the histology of adenomata of the thyroid (Figs 2-6), a greater difference than occurs in similar tumors in other organs. Adenomata of the kidney, for example, are relatively standard tumors, but one finds adenomas of the thyroid composed of solid embryonic cells, of cords or tubules, others made up of acini apparently of adult normal gland architecture, some like colloid goitre, and others in which degeneration, hemorrhage, cyst formation or calcification have occurred. In many of these, differentiation from the normal or simple hypertrophy type is impossible microscopically, the diagnosis depending usually upon the gross finding of a distinct capsule. This encapsulation is more marked in the localized or circumscribed form, where the growing mass presses on the adjacent gland and causes atrophy. Fibrous replacement occurs, and thus successive layers of capsule are laid down at the expense of the gland tissue. In the diffuse type the encapsulation is ill defined early perhaps due to a less rapid growth

of the individual masses We believe that a very large proportion of so-called colloid goitre is a late form of this diffuse type, the irregular lobulation with



FIG 3 —Adenoma resembling colloid goitre

fibrous septa, representing different sizes of adenomatous masses that have all progressed to the colloid stage, with different thicknesses of capsule in proportion to the amount of pressure atrophy and connective-tissue replacement This would restrict the diagnosis of colloid goitre to the group

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usually classified as simple hypertrophy of adolescence, a point of view clinically supported by the fact that so-called colloid goitre in the adult does

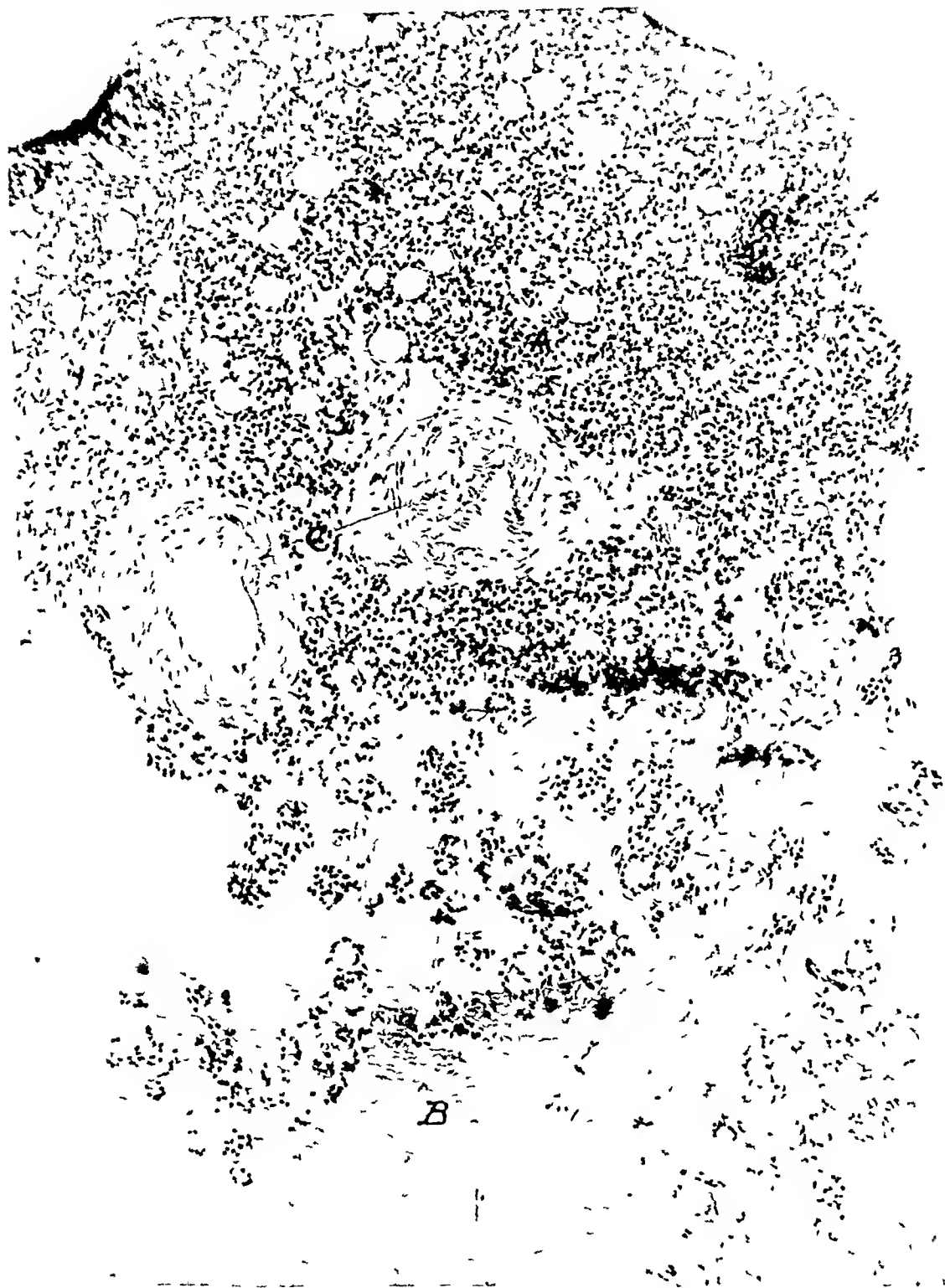


FIG. 4 —Adenoma composed of cords and tubules at A showing degeneration at B and thick-walled blood-vessels at C

not respond well to iodine therapy, at any rate in a coastal region such as New York

In discussing the aspect of function, we are up against an unsolved problem. Almost no adenomas are born toxic, many achieve it, and some

seem to have it thrust upon them by injudicious iodine administration. Many individuals carry inactive masses throughout life. A large number,



FIG. 5 —Adenoma composed of solid tissue at A and solid cords at B

usually in the late thirties, begin to have symptoms of hyperthyroidism, often without any noticeable change in their goitre. Furthermore, there is frequently nothing in the microscopical appearance of the specimen to differentiate it from an inactive mass. Usually the cells in the active type tend to a more columnar form, and the free margin may be somewhat fuzzy in

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appearance, but this finding is by no means constant. We have attempted mitochondria studies in some of these cases, but without sufficiently satisfactory results to justify an opinion one way or the other.

The symptoms of adenoma with hyperthyroidism hardly require any



FIG. 6.—Capsule of adenoma with dense fibrous tissue at A, looser fibrous tissue at B, with compressed acini and degeneration at C.

further description. Plummer many years ago described this type as pure hyperthyroidism, differentiating it from the more complicated activity as seen in exophthalmic goitre, the symptoms of which the Mayo Clinic group, as well as many others, believe to be due to an altered and excessive rather than a simply excessive secretion of the active principle of the gland. That the adenoma itself does cause the symptoms seems proved by the prompt and lasting cure produced by the complete removal of only the adenomatous tissue.

Where several adenomas occur some gland tissue as well must be taken, and in general it is better to do a bilateral subtotal operation in all cases in order to be sure of removing small, not readily palpable lumps. However for the purposes of argument as to the activity of these masses, if one merely enucleates a single mass, and there results a complete cure from a very definite group of symptoms one is warranted in assuming that the particular mass removed was responsible for the symptoms. What the cause or causes may have been that spontaneously changed an inactive into an active adenoma is not known. Jackson¹ reported 38 cases in which the administration of iodine was associated with the onset of hyperthyroidism. This occurred in two of my cases two years ago, and I have seen two or three other cases that have received iodine from their private physicians. Fortunately my own cases were mild ones, but they served as good warnings as to the danger of giving iodine to adults with adenoma. The relationship between the spontaneous and induced type may not be as distant as it now appears when we learn more about the whole subject of iodine metabolism in relation to the thyroid gland in health and disease, and when we are able to explain some of the apparent inconsistencies in the action of iodine in exophthalmic goitre, in particular its most helpful but usually transitory effect.

One can be brief in the discussion of forms of therapy, for operation is the most successful one. It is of course indicated where pressure symptoms occur. In the inactive cases it is indicated not only for cosmetic reasons, but also as a prophylaxis against hyperthyroidism and malignancy.

We have no census tables as to the number of adenomas of the thyroid in the United States, and we can but guess at the percentage which become toxic. Inasmuch as about 40 per cent of the cases of adenoma of the thyroid operated on at the Presbyterian Hospital in the past five years have had associated hyperthyroidism, and figures from other clinics also show a high percentage, it is fairly clear that hyperthyroidism may be expected in many cases. All writers on malignancy stress the probable preexistence of adenoma, and this must also be considered as a possible danger, although we are again unable to quote the mathematical risk of any given simple adenoma becoming malignant.

Radiotherapy occasionally helps the hyperthyroidism of adenoma, but has no effect on the lump, and is far too unreliable to be depended upon. Operation offers a cure, and should be done as early as possible. The unsatisfactory results in our series are due mainly to two causes. Firstly, to recurrences because of incomplete operation, and secondly, to persisting cardiac symptoms, due to damage that had occurred prior to operation. The first of these can be avoided by better technic, the second by earlier operation. Real myocardial damage which occurs more often in adenoma with hyperthyroidism than in exophthalmic goitre, perhaps due to the greater average age of the individuals afflicted, is the main source of danger in this disease, not only in relation to the interval results in the follow-up, but also as to the operative mortality. True post-operative hyperthyroidism is rarely seen in adenoma.

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cases, but cardiac failure in the severe cases is much to be feared. Lahey⁵ has called particular attention to this thyrocardiac group and their dangers, but has emphasized the possibilities in careful handling of these difficult cases. Thyroidectomy before the development of cardiac damage is as essential as appendectomy before the development of generalized peritonitis.

A good exposure and a wide removal are, we believe, the two most important points in the operative technic. We seldom fail to divide both groups of preglanular muscles, as the time spent in their repair is more than made up by the greater ease of the procedure. Being content with simple enucleation of single masses in our earlier cases, we had several recurrences, but now do a bilateral subtotal operation unless the opposite lobe is as small and soft as one could desire. In the diffuse adenomatosis with hyperthyroidism, one is faced with the same problem as in exophthalmic goitre and one must leave as little active tissue behind as is possible. By closure of the capsule one can usually avoid drainage, but when this is necessary, as for a large dead space, it is better to have the drain emerge through the muscles on the side of the neck after careful closure of the muscles in the midline, thus preventing attachment of the scar to the pretracheal fascia, and also procuring more direct drainage.

Intrathoracic goitre should be operated upon under local anæsthesia, so that one may have the benefit of the patient's voice to give warning against division of the recurrent laryngeal nerve, and to minimize respiratory difficulty.

I wish to add my endorsement to Guthrie's⁶ recent recommendation that Pemberton's technic be followed in these cases. Anyone who has suffered the tribulations of attempting to control inferior thyroid hemorrhage while the field was blocked by a large adenoma covering the retroclavicular space, and then follows his simple and logical technic, can appreciate his contribution to thyroid surgery.

CONCLUSIONS

- 1 Adenoma of the thyroid arise from the so-called interstitial cells
- 2 The natural history of the cells of adenomata, whether circumscribed or diffuse, is the same as for the cells of the gland itself
- 3 Operation is the best treatment for all adenomata of the thyroid
- 4 Early operation is essential
- 5 Iodine should be avoided in adult cases
- 6 Pemberton's technic should be used for intrathoracic goitre
- 7 Encapsulation is of more value in diagnosis than the microscopical appearance

REFERENCES

- ¹ Jackson. Am J Med Sc, 1925, vol cxv, p 271
- ² Goetsch. Endocrinology, 1920, vol ix, p 389
- ³ Else. J A M A. 1925, p 1878
- ⁴ Falk. Arch Surg. 1925, vol xi, p 74
- ⁵ Lahey. S G O, 1924, vol xxxix p 10
- ⁶ Guthrie. ANNALS OF SURGERY, 1926, vol lxxvii, p 251

THE VASOMOTOR REFLEX ARC

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The following case report is of interest because of the light it throws on the sympathetic innervations of the blood-vessels

J. C., white female, aged fifty-eight, entered the hospital, May 12, 1926, complaining of marked pain and swelling in the left arm. She gave a history that about eighteen months before she had had sudden shooting pains in the left breast. She then noticed that she had two small lumps about the size of walnuts in the lower outer quadrant of the left breast. A physician was consulted and local excision of the masses attempted. This was followed by the injection of some medicine into the remnant of the breast, which left a raw foul-smelling surface.

Four months later a radical excision of the breast and axilla was done. This was followed by X-ray treatment of the breast, arm, axilla and shoulder.

Some swelling of the fingers of the left hand was noticed soon after the operation. About nine months ago there developed a swelling of the entire upper extremity, beginning in the fingers and progressing upward. There was extreme lancinating pain, especially in the fourth and fifth fingers. Arm and hand have become progressively more swollen. Lately much more pain in the upper arm. Extreme aching at night which she describes as "just like a toothache."

Past negative except cholecystectomy many years ago.

Examination reveals a woman apparently about sixty, who is quite obese and well built, and is in excruciating pain. Nothing abnormal noted except left arm and chest. The left breast is missing. There is a scar running from the region of the xyphoid diagonally upward into the left axilla. This scar is loose and pliable. The subcutaneous fat on the anterior chest wall was not removed and there is every evidence of good wound healing. The entire left arm is enormously swollen. It pits deeply on pressure. The skin is tense and dry. This swelling extends on the chest wall both anteriorly and posteriorly. The anterior axillary border overhanging the scar consists of a series of swollen tags 5 to 15 cm. in diameter.

Careful search of the entire body shows no signs of metastatic carcinoma. No nodules can be felt on the chest wall or in the axilla although it is impossible to palpate the upper axilla on account of the oedema. The lungs are negative both to physical examination and X-ray. The long bones reveal no tender areas or X-ray defects.

Blood and urine normal.

Diagnosis—Lymphoedema of the arm.

May 10, 1926, May 24, 1926. Pain has been severe. One and one-half gram morphine needed in twenty-four hours. For ten days the patient was kept in bed with the arm elevated in a perpendicular position. This was excessively painful and necessitated large doses of hypnotics, but there was no change whatsoever in the size of the arm.

It was thought that the removal of the arm was out of the question as the disease extended onto the chest walls. Alcohol injection of the nerve roots seemed dangerous on account of possibility of involving the phrenic. As any lengths were warranted to relieve the intolerable pain, it was decided to section the posterior roots of the entire brachial plexus.

This operation was done May 29, 1926. The first dorsal was ligated and cut first and the pupillary changes noted. Then the eighth, seventh and sixth cervical were ligated and cut and the fifth cervical crushed in a heavy clamp. The dura was closed.

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and the wound sutured in the usual manner. Subsequent neurological examination by Dr. George Hassin showed anaesthesia in the skin areas of these nerves. Horner's syndrome was present. The pain ceased to such an extent that morphine was no longer required, but an unpleasant feeling of heaviness in the arm persisted.

The remarkable feature was that *within forty-eight hours the lymphoedema had entirely disappeared from the hand and most of the arm*. Some swelling persisted about the shoulder and especially in the anterior axillary folds, probably the areas of the second dorsal and the fourth cervical which were not cut. The left hand was noticeably warmer than the right in spite of the apparent interference with the circulation. Extreme wrinkling of the deflated skin was seen. This condition persisted for about a week when the oedema began to recur and at the end of about a month, the arm was in the same condition as before the operation.

Summary—Posterior root section in a case of obstructive oedema of the arm produced such extreme vasodilation that the oedema almost disappeared. This was a transient phenomenon and recurrence took place in about a month.

Discussion—One is struck at once in this case by the exact similarity of the results to those obtained in periaxillary sympathetomy. It seems reasonable to assume, therefore, that a very similar interruption in the reflex arc controlling vascular tone has been produced.

The exact paths of the efferent and afferent loops of the vasomotor reflex arc have been the subject of an enormous literature, which has received extensive additions in the last few years on account of the large amount of surgery done in this field. Jonnesco's and Jaboulay's earlier work has been brought to our attention again and the subject carried much further by the extensive researches of Leriche^{1, 2, 3, 4}. Most of the authors in this work take the view that when one does a periaxillary sympathetomy, one cuts the motor nerves to the vascular walls, paralyzing them temporarily, and that, in the course of time, these rather primitive muscles have the power to assume an independent tonus in the same manner as the intestinal or cardiac muscle.

Wiedkopff⁵ saw no reason to believe that there were any sympathetic afferents in the periaxillary plexus. Ranson⁶ says in concluding a résumé of our knowledge of this field, "It will be evident from the foregoing discussion that no satisfactory explanation of the hyperemia following periaxillary sympathetomy has yet been presented." Leriche in a series of investigations does not arrive at any very definite conclusion but suggests that the sensory limb of the arc may be involved.

The difficulties in this field are much enhanced by the fact that in most experimental animals, especially in dogs, these changes so striking in man, are almost totally absent. This fact has received beautiful experimental proof in the careful work of Lehman⁷. Leriche also agrees with these observations.

The opposite viewpoint has been admirably stated by Hahn⁸. He believes that the results of sympathetomy are due to the interruption of

* What then is the mechanism of periaxillary sympathetomy? Long centrifugal paths are not sectioned. That any long centripetal nerves lying in the adventitia are thereby interrupted. By this means a great part of the centripetal path for vasoconstrictor tonus are interrupted, then this constrictor tonus is abolished, which is equivalent to a hyperemia.

the sensory arc of a reflex. Cutting the sympathetics about an artery causes a loss of tonus due to the stoppage of afferent impulses necessary to maintain tone. This point of view seems far more rational as it is much easier to explain on this basis why the tone returns, when after a few weeks other sections of the afferent limb take over the work.

The observation of Kioggh, Harrop and Rehberg¹⁰ that stimulation of the ganglia in the sympathetic chain causes vasoconstriction could in itself be interpreted as a stimulus of either branch of the arc. Leriche and Policard¹¹ have, however, demonstrated that vasoconstriction is brought about by stimulation of the periarterial sympathetics. Bayliss¹² appears to have made the only observation on the vasomotor fibres in the posterior roots. He showed that stimulation of the posterior roots caused vasoconstriction.

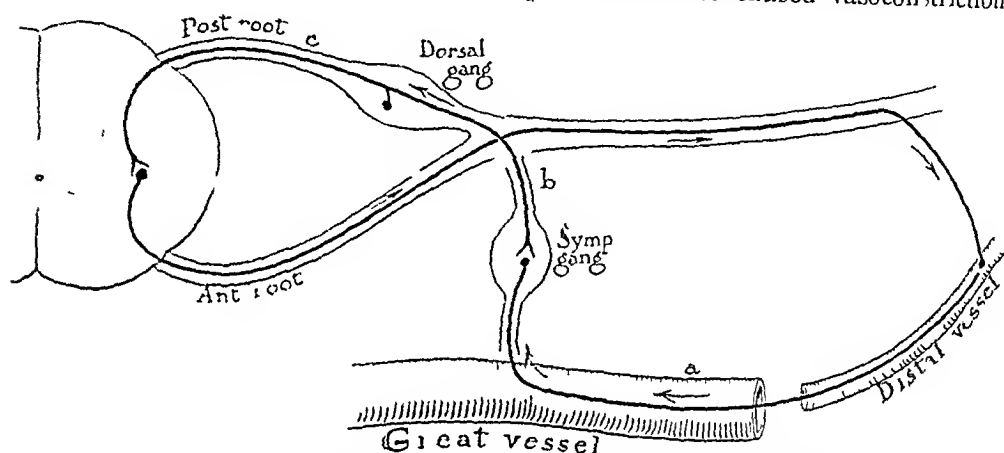


FIG. 1.—Diagram of the sympathetic reflex arc vasomotor control as postulated by the author. A, B and C represent the three points at which interruption of this arc brings about a very similar vasomotor effect. Point C, the posterior root, being obviously afferent it seems reasonable that points A and B lie on the efferent arc.

Periarterial sympathectomy as is well known causes a temporary vasodilation of the corresponding limb. It is also well known that ramisection, the operation popularized by Royle and Hunter, produces an exactly similar result. The experience of many surgeons has shown that while its effect on muscular tone is exceedingly doubtful, the vasodilation produced is constant, evident and marked. The case reported adds a third point, that is, that section of the posterior roots produces an exactly similar effect, marked temporary dilation. It seems, therefore, perfectly reasonable to assume that in each of these cases we are severing the same tract at a different level as the effect seems to be so similar. One cannot possibly believe that the posterior roots contain any but sensory fibres, and therefore, the conclusion is justified that the entire tract which is covered by these three types of operation is a sensory one.

What then is the course of the vasomotor reflex arc? Potts¹³ and Kramer and Todd¹⁴ have shown that numerous sympathetic fibres reach the vessels in their more distal portions directly from the spinal nerves. This is especially true in the skin. It is well known that stimulation of distal segments of spinal nerves causes vasoconstriction and here we are dealing with a motor stimulus. We may assume that the efferent vasomotor tracts leave the spinal

THE VASOMOTOR REFLEX ARC

cord in the anterior roots and gain access to the vessels through the spinal nerves, reaching the smaller branches or more distal portions of the larger trunks below the level at which sympatheticectomy is ordinarily performed. The afferent limb follows upward in the adventitia of the artery until it gains entrance to the ganglia of the sympathetic chain, entering the cord through the posterior roots. Langley¹⁵ has made it clear that the afferent limb of this arc in all probability consists of at least two neurones, synapsis probably occurring in the sympathetic ganglion and in the posterior root ganglion as well as many cases. (See Fig 1.)

This assumption also does away with the necessity for assuming two sets of nerves to the vessels, constrictors and dilators. Interruption of one or the other limb in the reflex arc can produce any of the various phenomena which have been noted in this connection.

Finally it may be noted that this case also shows clearly that there are afferent sympathetics in the cervical region. The absence of white rami in the cervical region has been noted by Ranson¹⁶ and others. Vogt¹⁷ describes the nucleus sympatheticus lateralis superior as extending upward including the eighth cervical. Even in the absence of white rami, it is clear from the results in this case that afferent fibres must be included with the efferent in the gray rami.

BIBLIOGRAPHY

- ¹ Leriche *Comp Rendu soc de bio*, vol lxxx, p 66, 1917
- ² Leriche *Arch de mal du coeur*, vol x, p 79, 1917
- ³ Leriche *Presse med*, vol xlv, p 513, 1917
- ⁴ Leriche *Lyon chir*, vol xlvii, p 703, 1920
- ⁵ Wiedkopff *Munch Med Woch*, vol lxi, p 413, 1925
- ⁶ Ranson *J A M A*, vol lxxxi, p 30, 1923
- ⁷ Leham *ANNALS OF SURGERY*, vol lxxvii, p 30, 1923
- ⁸ Leriche *Lyon chir*, vol xlvii, p 392, 1920
- ⁹ Hahn *Zent f Chir*, vol lxi, p 9, 1925
- ¹⁰ Krogh, Harrop and Rehberg *J of Physiol*, vol lvi, p 179, 1922
- ¹¹ Leriche and Policard *Paris med*, vol xi, p 27, 1921
- ¹² Bayliss, quoted by Krogh *Anatomy and Physiology of the Capillaries*, 1922
- ¹³ Potts *Anat, Anzeiger*, vol xlvii, p 138, 1914-1915
- ¹⁴ Kramer and Todd *Anat Record*, vol viii, p 234, 1914
- ¹⁵ Langley *Schaeffer's Textbook of Physiology*
- ¹⁶ Vogt *Handbuch der Neurologie*, 1910, p 146

MALIGNANT GROWTHS OF THE THYROID*

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THE whole conception of malignant growths of the thyroid was enveloped in considerable mystery until recent years. Even now many features are uncertain. Three factors have been responsible for this confusion.

1. The apparent rarity of malignancy in this organ has resulted in a somewhat limited opportunity for clinical and pathological observation and classification.

2. The histological pictures vary to an astonishing degree, so that even well-trained pathologists often find it difficult and even impossible to determine whether a goitre is or is not a malignant growth from the study of tissue sections.

3. A careful follow-up as a means of determining the true condition in doubtful cases has been generally neglected.

Sixteen malignant growths of the thyroid have been observed at the New York Hospital in recent years. I am indebted to Dr. John Rogers for the records of five of these. Since the object of this paper is to analyze what may be done by surgery, the results in these cases are presented.

Fourteen Carcinoma. Post-operative—Five died within 8 months, local extension or metastases. Three died in about 3 years, metastases. Two lost in 1 and 2 years, respectively, but presented local recurrence. One post-operative death. Three apparently well but less than one year after operation. Two sarcoma (lymphosarcoma). These died within 8 months, local extension.

Many other cases have enacted considerable discussion as to the possibility of malignancy. These have been carefully studied by the pathologist and clinician, but no doubtful case has been listed as malignant. They include those cases of adenoma in which the pathologist reported histological evidence of malignancy but no recurrence occurred.

On account of the uncertainty which often exists in pronouncing certain cases of goitre as malignant, it is well to review what is meant by malignancy.

Ordinarily the term implies immature or embryonic type of cell, rapid growth, peripheral extension, with infiltration of the surrounding tissues, tendency to develop metastases, tendency to central degenerative changes, liability to local recurrence after removal and systemic manifestations as cachexia (Adam).

These qualifications, however, cannot be unreservedly applied to malignant growths of the thyroid.

Attempts to classify the various types of carcinoma of the thyroid result in artificial and confusing tables which serve no useful purpose. Classifications as given by Langhans and Kocher are not appropriate on account of

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transition of one group into another. It is sufficient for our purposes to appreciate certain broad subdivisions.

Carcinoma may originate in the thyroid parenchyma, in an adenoma, or in aberrant thyroid tissue.

Carcinoma originating in the thyroid parenchyma may show histologically an extremely lawless cellular growth with all the evidences of extreme malignancy or the type may be an adeno-carcinoma or papillary adeno-carcinoma, with little to suggest malignancy. These neoplasms follow the tendencies of growth and invasion which are noted in carcinoma elsewhere. The growth invades the thyroid to a variable extent, even crossing the isthmus to the other lobe, ultimately reaches and infiltrates the capsule of the gland and infiltrates adjacent tissues, notably the trachea. In contrast to malignant growths originating in adenomata, metastases occur mainly by the lymphatics, the regional nodes being first involved.

Carcinoma originating in an adenoma has recently excited much discussion and the study of this lesion has added greatly to the knowledge of malignancy of the thyroid. The subject demands somewhat extensive consideration.

An adenoma is a definite tumor formation. It is a round or oval circumscribed encapsulated mass within the thyroid parenchyma. In many cases multiple adenomata are present. Their structure is not uniform, they may present various types of tissue, notably embryonal, fetal or adult. The fetal is the most common and consists, in general, of concentrically arranged cells with no apparent lumen, the embryonal type shows an even less differentiated structure, while the adult presents acini with lumina containing colloid and conforming more or less closely to the normal thyroid structure. An adenoma often presents combinations or variations of these types, and often shows strands of cells without apparent coordination or arrangement. It is at once evident after observing such histological pictures how difficult it may be to recognize malignancy from the study of tissue sections.

These growths illustrate the doctrine of Ribbert of the unicentric growth of tumors, that is, growth occurs at the periphery and the most mature or central parts undergo degenerative processes which lead to secondary changes of fibrous, hyaline, or calcareous character. Central necrosis and hemorrhage often lead to the formation of cysts.

Carcinomata originating in adenomata are at first limited by the capsule of the parent tumor. When the growth has penetrated this capsule its progress is like that of a cancer originating independently of an adenoma. In a certain proportion of cases malignancy within the adenoma may be recognized microscopically by the morphology and arrangement of the cells. These characteristics may be confined to small areas or may be widely spread throughout the adenoma. In other cases grave doubt persists even after careful study, the cellular arrangement appearing lawless but nothing other than this feature suggesting malignancy. The recognition of invasive properties of the tumor, which is the best evidence of malignancy, is particularly

difficult in this organ when the growth has not passed beyond the normal capsule or the capsule of the adenoma. Irregularity in size of nuclei and cells ordinarily suggests turbulent growth, representing one of the factors embraced under the term anaplasia. But this feature is of far less significance in the growths of the thyroid than in malignant tumors developing from other glandular structures. In these doubtful cases Graham urges the importance of determining whether there is invasion of the blood-vessels as evidence of malignancy.

Graham's contribution will prove of great value if his interpretations prove correct. He concludes that the morphological character of the cells and tissue is an unreliable basis for the determination of malignancy of thyroid tumors, that their malignancy depends upon their tendency to invade adjacent tissues and that the most constant single indication of thyroid malignancy is invasion of the blood-vessels.

He states, further, that epithelial tumors that are encapsulated and show no invasion of the blood-vessels are benign, irrespective of their microscopic appearance.

From a practical viewpoint it must be emphasized that the examination of an adenoma for blood-vessel invasion is a somewhat prolonged procedure. It is not comparable to a rapid frozen section of a bit of suspected tissue, for instance, in the breast. It can therefore only be employed by a careful study of the tissues after the operation has been completed. In other words, it has a bearing upon prognosis but not upon the operative procedure. We have never been able to find true vascular involvement, although tumor cells have been found occasionally in spaces containing blood-cells.

In the Mayo Clinic from 1910-1916, 16 per cent of goitres exclusive of exophthalmic were classified as cancer (Balfour). Over 80 per cent of the patients were over forty years of age and the larger proportion were women. In almost all of the cases there was a long preexisting goitre. This supports Graham's statement that 90 per cent of malignant tumors of the thyroid originate in adenomata.

While we must accept the evidence that cancers of thyroid are preceded by, and develop in, adenomata in a large proportion of cases, there is no convincing evidence as to proportion of adenomata which become malignant.

Careful analysis suggests that possibly undue weight is now being attached to the probability of cancer developing in an adenoma. As one reviews the conditions which existed three to four decades ago when goitre operations were unusual and patients harboring adenomata did not in general accept surgical intervention, one is impressed by the fact that few cancers of the thyroid were noted, indeed far fewer than would have been seen if adenomata presented the marked tendency to malignancy which is at present generally assumed.

It may well be that undue importance has been attached to the finding in blood spaces or even in definite vessels within an adenoma of tissue of the same structure as that of the adenoma. The vessel walls of an adenoma are

extremely thin, they rupture and erode readily, as is shown by the tendency to hemorrhage in the central portions. The apparent presence of tumor tissue within vascular spaces might represent non-malignant extension or might be an artifact due to handling or cutting the tissues. Definite invasion of the vessel wall or growth of tumor tissue along the intima should be recognizable to be convincing as to the malignancy of the adenoma.

An obvious argument in favor of the possibility of non-malignant extension within the vessel is the long-accepted teaching that non-malignant metastases, especially in bone, occasionally occur in association with the growth of a simple goitre. This impression which was originated by Cohnheim half a century ago has been unquestioningly accepted by most of his followers, but has been attacked recently, notably by Bériard and Danet.

They state that Wolflei examined the sections in Cohnheim's case and found evidences in the thyroid suggestive of malignancy. They also analyzed a number of reported cases bearing upon this subject. For instance, in 1910, Vellot published a case of a man of sixty-eight from whom a tumor in the lumbar region was removed, which presented the structure of the thyroid gland. The thyroid showed only a very small nodule which did not increase in size during the subsequent fifteen months. Yet, recurrence of the metastasis occurred and the patient died after a second operation. Examination of the thyroid then showed a small encapsulated apparently benign adenoma which, however, in one area on microscopic section showed what was considered typical carcinoma. Crone in 1914 published similar cases. On the basis of such observations the authors consider it necessary to revise the views bearing upon so-called benign metastases from simple goitres. They consider that a metastasizing goitre is a malignant goitre, and deny the fact that thyroid tumors differ in this respect from the general rules bearing upon the evolution of new growths. Simpson reaches the same conclusion, namely that there is no such entity as a benign metastasizing goitre.

The difficulties encountered by the pathologist in determining the existence of malignancy in this organ must be emphasized. Frequently the whole gland is diseased and cancer develops only in one portion. The pathologist should therefore receive all the tissue removed at operation, fresh and unfixed. When the tissue has been fixed its texture and color are changed and it is more difficult to recognize suspicious areas. As already stated, the recognition of invasive properties of the tumor is usually difficult and the occurrence of irregularity in size and arrangement of cells and nuclei has less significance than in other organs.

The careful pathologist no longer relies in tumors of the thyroid solely upon the histological picture. A correct diagnosis is best ensured by consideration of the clinical course, careful inspection of the gross material in recent state in conjunction with examination of sections from suspicious areas or in the absence of such areas, from many portions of the gland. Cooperation between the surgeon and pathologist is essential.

A careful review of the evidence then, indicates, that—

1 Most malignant growths of the thyroid originate in preexisting adenomata, the incidence of such development is, however, uncertain

2 The histological picture often is not conclusive either for or against malignancy

3 True vascular invasion is a conclusive criterion of malignancy. This feature, however, is difficult to recognize

4 The long-accepted teaching that metastases occur from benign goitres is unsupported by facts

Metastases—There are certain characteristics in regard to thyroid metastases to which attention should be called. Lymphatic invasion is more frequent in carcinoma originating in the parenchyma, blood-vessel invasion is more frequent in carcinoma originating in adenomata

Whereas metastases may develop in bones or viscera, there is a striking tendency for their occurrence in bones. Mammary carcinoma alone equals carcinoma of the thyroid in the frequency of bone metastases. The metastases in bones may be multiple or solitary. In some the primary focus remains latent, and the metastases dominate the clinical picture, the original focus presenting nothing of clinical significance to attract attention to it.

A metastasis is usually of relatively slow growth and may appear to be a solitary tumor for a considerable period.

It is generally believed, on the basis of v. Eselsberg's case, that a thyroid metastasis may function similarly to the apparently normal thyroid gland and act vicariously for the thyroid. Yet, this is at variance with one of the precepts in regard to malignancy, that malignant cells do not function. In v. Eselsberg's case total thyroidectomy was followed by myxœdema and tetany. These persisted until a metastasis developed in the sternum. Four years later the metastasis was removed and myxœdema recurred.

I will omit discussion of carcinoma in aberrant thyroid tissue as well as the symptoms and course of the disease, except to state that the course is relatively slow and death occurs from the effects of the infiltration of adjacent structures or as the result of metastases.

Diagnosis—In early cases of carcinoma, especially those originating in an adenoma, there are no clinical features to suggest the diagnosis. Balfour, in discussing the clinical aspects, states that in only 18 per cent could a positive diagnosis of malignancy be made clinically. In 46 per cent malignancy was not suspected before operation. He stresses the fact that the cancer lies concealed within the thyroid for some time before reaching the surface or undergoing systemic dissemination.

The development of a mass or tumor in the neck, or more frequently, increase in the size of an existing goitre, is usually the first feature to attract the attention of the patient. The growth is always progressive with no periods of regression. Irregular and nodular surface, firm, even hard, consistency, are usual with malignancy. In some cases, dysphagia, dyspnœa, hoarseness and radiating pains are the first features observed by the patient. These signs always indicate that the neoplasm has already passed beyond the

thyroid, and are therefore late symptoms. Errors have occasionally arisen in Chronic thyroiditis and strumitis, tuberculosis or syphilis of the gland or hemorrhage into a cyst. But in such doubtful cases, a careful history and physical examination will usually readily clear up the diagnosis. The so-called iron stroma or Riedel's thyroid, however, may occasion confusion. In this, dyspnoea due to compression of the trachea is the outstanding symptom. Although the thyroid is extremely hard and fixed, it may be differentiated from malignancy by the fact that it does not show progressive growth, in fact, since the late stage represents a replacement fibrosis of the thyroid parenchyma, it is not associated with any increase in the size of the gland.

Treatment—Carcinoma in and confined to an adenoma must be considered independently. And this is the feature upon which emphasis should be laid, because it offers conditions favorable for treatment. Experience has shown that a large percentage of thyroid cancers begin in adenomata, many of them in adenomata of long standing, that for a considerable period no clinical evidence indicates the fact that carcinoma has developed, that the histological picture is often not typical. While careful study of the tissues may demonstrate the malignant nature of the lesion, recurrence is often the first indication of it. Not infrequently this has occurred in relatively young individuals, even as early as the third decade.

It is evident that a rapidly growing adenoma, especially in middle life, must be regarded with suspicion and should be treated as malignant. The proper procedure in these cases is resection of such portions of the thyroid as contain adenomata. This may include parts of both lateral lobes and isthmus. Such a procedure is relatively easy and free from danger.

Multiple adenomata in general demand resection, solitary adenomata, especially non-toxic, may be enucleated. These procedures are referred to here since they may be regarded somewhat in the light of prophylactic measures, namely, the removal of potentially malignant tissue.

Considering the relative infrequency of cancer of the thyroid, it seems unwise to alarm a patient by the suggestion of malignant potentialities. While the removal of adenomata should be urged, the probabilities of the development of toxic symptoms are a sufficient argument in most cases to ensure consent to operation.

Carcinoma originating in the parenchyma, or secondarily involving the parenchyma by extension through the capsule of an adenoma, constitutes the type of carcinoma which was exclusively recognized before the significance of adenomata as the favorite nidus for cancer growth was appreciated. Under these conditions the cancer is diffuse and infiltrating and since its clinical evidence is at first obscure, it often reaches an advanced stage before aid is sought and before the true condition is appreciated by the surgeon.

Unfortunately when the diagnosis of malignancy is definite the case is usually beyond the possibility of cure by surgery. If the growth has penetrated the capsule of the thyroid and has invaded the adjacent tissues, even radical operation can accomplish nothing. Suspicion of malignancy,

therefore, is the indication for operative interference. It is to be regretted that little aid in clearing up the uncertainty can be obtained by examination of frozen sections since the histological appearance varies so much and so rarely offers a typical picture that reliance must be placed chiefly on clinical criteria. While radical operation is interpreted as complete or almost complete removal of the thyroid, it is obvious that decision as to such a step must be difficult. If the lesion is confined to one lobe, especially if it is not assuredly cancerous, the other lobe naturally should not be completely removed. On the other hand, if the case is unquestionably one of cancer, generally both lobes are involved, the capsule has been penetrated and adjacent tissues invaded. Under such conditions complete removal of the thyroid will subject the patient to discomfort and risk without offering hope of a radical cure. Therefore, while total extirpation of the gland is theoretically the proper procedure, it is only rarely indicated because in cases of limited extent it is too much and in advanced cases it is too little.

That opinions differ in regard to total extirpation of the thyroid is evidenced by contrasting the views of various surgeons. Thus, Von Eiselberg and Kochei preserved a piece of the gland, Kausch recommended complete extirpation and Sudeck performs total extirpation when he operates at all, but he claims remarkable results with Rontgen irradiation. He therefore operates on no case in which metastases are demonstrable or where the tumor has invaded the neighboring tissues.

Operative Results—In Balfour's report there were 65 per cent operative or early post-operative deaths from the disease. The late results of the remainder are still uncertain. The great majority of apparent cures occurred in those cases in which the malignant change was an unexpected finding. Total thyroidectomy was rarely performed in this group. In most instances the lobe containing the tumor and the malignant process was removed, but in many the enucleation of an adenoma was the procedure.

Irradiation—In view of the uncertainties of operation in advanced cases irradiation must be given serious consideration. Most radiologists agree that carcinoma of the thyroid is remarkably sensitive to radiation.

One might summarize what has been said somewhat as follows:

Removal of adenomata is the best means of treating cancer of the thyroid. It constitutes a prophylactic procedure.

If carcinoma is discovered after the removal of an adenoma, thorough post-operative radiation is indicated.

Cancer not limited to an adenoma is rarely cured by surgery.

When the clinical diagnosis of cancer is definite, irradiation is in general preferable to bold efforts at radical extirpation.

Sarcoma—Sporadic cases of sarcoma have been reported. Since the thyroid contains in its stroma considerable connective tissue, there is no reason why sarcoma should not occasionally develop therein. Yet the epithelial tissue is vastly in preponderance and is a highly functioning epithelium. Therefore the relative frequency of sarcoma might well be expected

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to be small. The differentiation from carcinoma in an individual case offers difficulty by reason of the great variety of forms which carcinoma may present. Ewing states that the occurrence of sarcoma, implying by this definite evidence of mesoblastic origin of the tumor, still requires demonstration. No detailed consideration of sarcoma is possible since the rare individual cases which undoubtedly occur have not been grouped and excite discussion chiefly in the effort to prove or disprove that they are sarcomata. But in most cases the discussion leaves even this feature in doubt. Yet DeQuervain states that all varieties of sarcoma occur in the thyroid.

His views represent the prevailing impression and teaching.

BIBLIOGRAPHY

- Aschoff, L. The Goitre Problem, a Morphological Study. Lectures on Pathology, N. Y., 1924.
- Adam, J. G. Concerning the Causation of Cancerous and Other New Growths. Monograph, New Haven, 1901.
- Balfour, D. C. Cancer of the Thyroid. Medical Record, 1918, vol. xciv, p. 846.
- Barry, J., and Dunhill, T. Malignant Disease of the Thyroid. Proc. Roy. Soc. Med., 1925, vol. xviii, p. 25.
- Berard, L., and Dunet, C. Le goitre metastatique, existe-t-il? Revue de Chirurgie, 1921, vol. lix, p. 521.
- Binnie, H. Tumor of Aberrant Thyroid. Boston Medical and Surgical Jour., 1924, vol. cxciv, No. 7, p. 227.
- Bouman, H. A. H. Minnesota Medicine, 1920, vol. iii, p. 105.
- Breitner, B., and Just, E. Mitt. a. d. Grenzgeb. d. Med. Chir., 1924, vol. xxxviii, p. 262.
- Breitner, B. Wiener Med. Wochenschr., 1925, vol. lxxv, No. 2, p. 127.
- Ehrhardt, O. Beitr. f. allg. Pathol. u. pathol. Anat., 1902, vol. xiii, p. 379.
- Coller, F. A., and Barker, H. B. Endemic Goitre, a Precancerous Lesion. Michigan Med. Soc., 1925, vol. xxiv, p. 413.
- Ciaver, L. F. ANNALS OF SURGERY, 1925, vol. lxxxi, p. 833.
- Cronq. Beitr. z. Klin. Chir., 1914, vol. xliii, p. 83.
- DeQuervain. Struma Maligna. Wullstein-Kuettner, Lehrbuch der Chirurgie, 1923, vol. i, p. 354.
- Eiselberg, Von. Arch. f. Klin. Chir., 1894, vol. xlviii, p. 489.
- Fisen, D. Malignant Tumors of Thyroid. Amer. J. Med. Science, 1925, vol. xvii, p. 61.
- Ewing, J. W. B. Saunders Co., Philadelphia, 1919.
- Graham, A. Surg., Gynec. and Obst., 1924, vol. xxix, p. 78.
- Kaufmann. Corresp. Blatt f. Schweizer Aerzte, 1904, vol. xciii, p. 540.
- Kocher, Th. Dtsch. Zeitschr. f. Chirurgie, 1907, vol. xci, p. 197.
- Kausch, W. Archiv f. Klin. Chir., 1910, vol. xciii, p. 829.
- Hueck, H. Struma Maligna. Arch. f. Klin. Chir., 1924, vol. cxxxviii, p. 45.
- Kamsler, A. Arch. f. Klin. Chir., 1923, vol. cxxvii, p. 624.
- Langhans, T. Ueber die Epithelien Formen der Malignen Struma. Virchow's Archiv, 1907, vol. clxxxix, p. 69.
- Mason, T. P. Carcinoma of the Thyroid. Surg. Clin. North America, 1924, vol. iv, p. 1121.
- Meleney, F. L. ANNALS OF SURGERY, 1922, vol. lxxvi, p. 684.
- Vignon, A., and Bellot. Presse Medicale, 1910, vol. xvi, p. 809.
- Muller, G. P., and Speese, J. Malignant Disease of Thyroid Gland. Univ. Penn. Med. Bull., 1906, vol. xix, p. 74.

- Parquier, Venot, et Bonnin Les Thyroides aberrantes laterales et leurs tumeurs Rev
de Chir, 1923, vol lxi, p 393
- Ribbert, H Die Entstehung des Carcinoms Monograph, Bonn, 1905
- Schaeffel, W Ueber Struma Maligna Munch Med Wchschrift, 1922, vol xlix, p 1282
- Schrager, V L Lateral Aberrant Thyroids Surg, Gynec and Obst, 1906, vol xlii
p 465
- Schnuppscher, H Ueber das Carcinosarcom der Schilddruse Zeitschrift f Krebsfor
schung 1923, vol xxi, p 19
- Simpson Surg, Gynec and Obst, 1926, vol xlii, p 489
- Sudeck, P Beitr z Klin Chir, 1925, vol cxxviii, p 533
- Walton A J Diagnosis of Malignant Disease of Thyroid Lancet, 1925, vol 1, p 630
- Wilson, L B ANNALS OF SURGERY, 1921, vol lxxiv, p 129
- Wolfler, A Ueber die Entwicklung und den Bau des Kropfes Monograph, Berlin,
1883

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held October 4, 1926

The President, DR CHARLES F MITCHELL, in the Chair

GASTRIC TETANY

DR W HAROLD STORM, by invitation, reported from the service of Dr A P C Ashhurst, at the Episcopal Hospital, the case of a man, forty-one years of age, who was admitted to the hospital August 23, 1926, with the history of a recent attack of acute appendicitis recurrens

On admission there was well-marked rigidity over the right lower quadrant, and though no mass could be felt and peristalsis was audible, and the patient did not appear ill, immediate operation was decided upon

At operation, August 23, 1926, an adherent gangrenous appendix was enucleated from a small abscess cavity and removed Four hours later, before complete recovery from anæsthetic, he had a very peculiar spell There was fixity of position of extremities and his eyes had a wild stare This condition lasted about an hour No epileptic history On the day following operation he complained of very severe gas pains and was given an asafœtida enema and rectal tube and was relieved Passed gas and voided

The following day he again complained of distention, which was only partially relieved by enema Fairly comfortable during night At the end of forty-eight hours, on August 26, the distention became worse during the day and was not relieved by an enema Eserin sulphate, gr 1/40, given hypodermically and repeated in an hour, gave some, but only temporary relief Enema brought no relief

On August 27, the patient presented the clinical picture of threatening acute intestinal obstruction Peristalsis could only be heard faintly at long intervals Rested more easily towards noon, but at 2 P M complained a great deal of the distention, which was extreme There was no pain At 6 30 P M patient could be heard groaning from a distance He had his arms extended, wincing his fingers and crying out with pain Had a very anxious expression on his face and was vomiting foul-smelling material Enemata gave no relief, but morphine and gastric lavage seemed to afford some relief Continuous enteroclysis and morphine ordered and nothing by mouth Patient rested fairly well after 9 P M and had no more pain

After two days of much relief, he developed, August 30, a violent diarrhoea Towards evening he had spasmodic convulsive seizures in which he threw his arms out from his sides and shrieked with pain and said he could not breathe because of a feeling of oppression beneath the sternum Upper abdomen ballooned up (stomach) and then went down with eructations of gas by mouth Temperature 102° Convulsive seizures were quite frequent, but occurring at irregular intervals These seizures continued during the next twenty-four hours

The blood was tested for chlorides, calcium, and CO₂ content, and the urine for chlorides Bl calcium, 10.01 mgms per 100 c c blood (normal is 10-12 mgms per 100 c c) Bl CO₂ combining power 70.8 volumes

per cent (normal is 60-83 volumes per cent) Bl chlorides, 200 mgms per 100 cc blood (normal is 450-500 mgms per 100 cc) Urinary chlorides as NaCl, 0.5 gm for 1000 cc urine. An intravenous injection of normal salt solution (750 cc) was given at 11 A M. At about 1 P M, 250 cc of 15 per cent solution of sodium chloride was given intravenously. During the administration of the hypertonic sodium chloride solution patient had a very severe convulsion, resulting in the displacement of the needles in the vein and spilling some of the solution into the subcutaneous tissues. This convulsion was by far the most severe of all. Eyes diverged, face looked as if it were being torn to pieces, both upper extremities went into a convulsive seizure. During none of the convulsions were the lower extremities noticeably involved. A duodenal tube was passed at 3 P M. The man had no more convulsions after the intravenous 15 per cent sodium chloride. The distended stomach went down after the passage of duodenal tube. Gastric analysis of one specimen from stomach (taken just after lavage) showed no free hydrochloric acid and only 25 total hydrochloric acid. During night he had severe diarrhoea but rested fairly well. Was fed cocoa, milk, orange juice, lemon juice, etc., every four hours, by duodenal tube, getting 250 cc each time. There were no more convulsive seizures, and on September 1, his condition was much improved, abdomen soft, stomach not distended, no vomiting, and diarrhoea checked. Convalescence was further complicated by the development of a pulmonary inflammation which is suspected to be tuberculous. He is still in the hospital.

DR A. P. C. ASHHURST remarked that the patient whose history had been presented by Doctor Storm is one of the complicated cases of appendicitis which is mentioned in his paper on "The Mortality in Appendicitis". This man survived. He was very sick at the time and Doctor Ashhurst believes that he was made very much worse by eserine. He had a gangrenous appendix, lying in a mass of adhesions. For tympanitis, three days after operation he was given a dose of eserine, causing too active peristalsis in the presence of a subsiding peritonitis and this in turn caused an intestinal kink and partial obstruction.

The first time he had used eserine was in a case of typhoid perforation with successful suture. After three to six days the patient became very much distended and a dose of eserine was given. The distention went down but the patient died, and at autopsy a second perforation was revealed. Since then he has been afraid of eserine in peritonitis. We should always remember that the patient is not sick because he is distended, but is distended because he is sick, the treatment, therefore, is not to reduce the distention, but to treat the sickness.

In the case reported by Doctor Storm, by washing the stomach and giving morphine, the patient was tided over the period of distention. Because of the obstruction the hydrochloric acid was not getting out of his stomach to be absorbed in the small intestine and this probably caused alkalosis. The patient's state was so very serious that he decided to give him hypertonic salt solution intravenously, which was done, and the patient got well.

DR JOHN H. JOYSON recalled a case reported before the Academy about a year and a half ago from his service at the Medico-Chi Hospital, which

MORTALITY IN APPENDICITIS

was one in which typical gastric tetany was observed following operation for a large inguinal hernia where the man vomited repeatedly after the operation. A Jutte tube was used to relieve him. The function of the Jutte tube is to relieve distention of the upper intestinal tract. Of the people that it keeps alive, a number are liable to develop alkalosis unless measures are taken to prevent it by hypodermoclysis of salt solution. Another case now convalescing is the third he has seen. This is a woman of thirty-nine who had incomplete intestinal obstruction. Operation revealed carcinoma of the ascending colon, for which resection of the terminal ileum, cæcum and ascending colon was performed. Acute dilatation developed on the second day and was relieved by the Jutte tube. She was all right for ten days when dilatation of the stomach again developed, due to adhesions around the pylorus. After treatment for several days with the Jutte tube, the patient became dehydrated and developed the typical symptoms of alkalosis. In view of her greatly dehydrated condition, glucose was administered intravenously in connection with hypodermoclysis. Four hundred cc of a 10 per cent solution of glucose and continuous hypodermoclysis were given the first day with prompt relief of the tetany and the next day 500 cc of a 25 per cent solution. Re-operation then relieved the adhesions around the pylorus. She made a good convalescence thereafter.

MORTALITY IN APPENDICITIS

DR A. P. C. ASHHURST read a paper with the above title, for which see page 89.

DR GEORGE P. MULLER said that Doctor Ashhurst's paper brings up the perennial discussion, and he does well to emphasize that the mortality is in the group of cases where abscess and gangrene and diffuse peritonitis are present. Two years ago Doctor Muller reported one year's work and yesterday he analyzed the past year's work. In neither one were there any deaths in acute appendicitis where drainage was not employed. Many of these cases were classed as peritonitis, *i.e.*, there was turbid fluid in the abdomen which when cultured showed microorganisms. Therefore, the problem is—as Doctor Ashhurst has said—in the drained cases.

In the past year he drained 36 cases and had 4 deaths, a mortality of 11.4 per cent. That is a high mortality. The total mortality for the whole group was 3.4 per cent. As compared with the year previous, when he showed 50 drained cases with 5 deaths (10 per cent) there is an increase of 1.4 per cent but actually the percentage of drained cases was less because they now close more cases without drainage.

GUEINV, of Columbia S. C. published a paper in the *ANNALS OF SURGERY* for last August in which he gives his results for 25 years, showing a total mortality of 11 per cent—688 cases with one death. The speaker had no deaths in two years in cases which were not drained. In the remaining cases he has a mortality of 21 per cent—(664 cases) and in the group of cases—not diffuse peritonitis cases—the mortality was 17 per cent.

The difference in mortality as reported by various writers makes one wonder whether the 10 per cent mortality is not too high. It leads one to question one's procedure. There is the question, how long shall one delay operations in these cases? A recent patient, fifty-five years of age, with a mottled abdomen, was placed on enteroclysis, Fowler position, etc., and seemed greatly improved, this was at 4 P. M., and he died the next morning. Autopsy showed the peritoneal cavity swimming with turbid fluid. He might have been better handled by decompression. The difficulty is to know what to do with persons who are terribly ill. He had had a number of operations on the third day, during which time the patients have had nothing by mouth. There is always the danger of throwing these patients into alkalosis. He used to think that the thing to do was to individualize the patient, and that it was better not to have a time schedule, as the delay in some patients might be six hours and in others two days. So far he had had nine deaths, five one year and four the next. Why does one have a mortality of 10 per cent, when Guerry only has $1\frac{1}{2}$ per cent to 2 per cent? One does not have enough cases to solve this question in one year or even two.

BENIGN BONY ENLARGEMENT OF THE CONDYLOID PROCESS OF THE MANDIBLE

DR ROBERT H. ILL read a paper with the above title, for which see page 27.

DR GEORGE P. MULLER called attention to an error in technic which he made the year before last in connection with this incision. He was removing the loose cartilage from the joint, it was easy to expose and to remove, but at the time he encountered some hemorrhage in the lower angle of the wound in trying to reach the vein, and urged the assistant to retract harder, so that he could examine the bleeding and stop it. The day following the operation the patient showed all the signs of facial paralysis. This was distressing, as the patient happened to be an actress. In three months' time, however, this disappeared with the exception of an inability to wrinkle the forehead, which is still the case. She was able to close her eyes, etc., and by wearing her hair over the forehead she is able to conceal the fact that she is unable to wrinkle it. The dragging down to look at the vein was sufficient to give enough injury to cause the palsy.

CARCINOMA OF THE THYRO-GLOSSAL DUCT

DOCTORS HUBERT R. OWEN and HELEN INGLBY reported the following case history. A woman, age forty-five years, was admitted to the Woman's College Hospital, Philadelphia, on September 21, 1925. Her chief complaint was swelling of her neck of three years' duration. No history of cancer in the family. Has been married for twenty-seven years. One child (deceased). She first noticed a swelling of her neck three years ago—very small in size, about the size of an almond. The tumor apparently began in the midline and extended to the left. This tumor grew slowly until one year ago when the growth became more rapid. Has never had any difficulty breathing or swallowing. She has noticed no hoarseness, undue perspiration,

CARCINOMA OF THE THYRO-GLOSSAL DUCT

palpitation or dyspnea. Claims to have lost about ten pounds in weight in the past year and has felt decidedly weaker. No history of insomnia. Appetite is good. Menstrual history normal.

From the midline of the neck in the region of the thyroid cartilage, extending to the left of the midline, there is a tumor the size of a hen's egg. It is not attached to the skin. There is no inflammation of the skin. The general consistency of this tumor is hard. There is, however, one soft area about the size of a walnut which apparently fluctuates. The tumor is not tender. It apparently moves with deglutition.

September 23, 1925, Doctor Owen, through a collar incision about three inches long, exposed the mass, which appeared to be cystic. Rupture occurred while attempting enucleation, cystic and colloidal matter escaped into the wound. The capsule of the tumor extended up to the hyoid bone beneath the sternum and beneath the sterno-hyoid muscle. It was impossible to remove the entire capsule, but as much as possible was tied and severed. Part of the stump of the capsule was left above and part below the cystic portion of the tumor.

March 1, 1926, the patient was readmitted to the hospital with a recurrence at the site of the operation. The size of the present tumor was about two centimetres in diameter, slightly to the left of the midline of the neck. The tumor was round, hard and adherent. A second operation



FIG. 1.—Part of the cyst wall (low power) showing aggregations of lymphocytes. Thick-walled vessels are visible. The dark spots are engorged vessels.

was performed March 2, 1926 through the scar of the former operation. Two small tumor masses were dissected out, one cystic, the second a hard fibrous mass. Both were attached to tracheal rings.

The excised portion of the cyst removed at the first operation had a wall varying in thickness from 0.5–0.3 mm and was irregularly loculated. There were several low projections on the inner surface. Microscopically the wall consisted of parallel bands of fibrous tissue in which were embedded dense masses of lymphocytes. Some of these closely resembled lymphoid tissue, i.e. they showed fairly defined reticulo-endothelial cells surrounded by lymphocytes. Others, especially the small perivascular groups, were clearly of inflammatory origin. The inflammation extended into the surrounding muscle which was infiltrated by small round cells and, in many places, invaded by fibrous tissue. The blood-vessels were thick-walled and for the most part dilated. Here and there in the cyst wall small vesicles lined by cuboidal cells were seen. Their structure recalled that of the thyroid, but they contained no colloid. Although not typical they were interpreted as rudimentary thyroid vesicles which are often seen in the walls of branchiogenic and thyroglossal cysts. No characteristic epithelium could be found lining the cyst.

This was hardly surprising in view of the size of the cyst and the inflammation of its walls, but it is unfortunate as it prevents exact diagnosis.

The diagnosis made at the time was that of branchial or possibly thyroglossal cyst. The grounds on which this conclusion was based were (a) the characteristic fibrous tissue wall, (b) the presence of lymphoid tissue, (c) the presence of rudimentary thyroid tissue. The lymphoid tissue may have been formed simply in response to the invasion by carcinoma cells and the rudimentary thyroid vesicles might be interpreted as a part of the growth. Nevertheless, it is clear that a cyst existed for some considerable time before the malignant growth. Had this been a cyst of the thyroid gland itself, it seems impossible that thyroid tissue should not have been found in its immediate neighborhood, but none was present. Its situation and character do

not correspond to any form of cyst and therefore we adhere to the original diagnosis of a cyst derived from embryonic rests, probably from the pharyngeal pouch corresponding to the third branchial cleft, *i.e.*, the thymopharyngeal duct.

The pieces of tissue removed at the second operation microscopically revealed a typical papillary adenocarcinoma. The growth consisted of cuboidal cells with pale vesicular nuclei and irregular ill defined, often vacuolated protoplasm. The cells some-

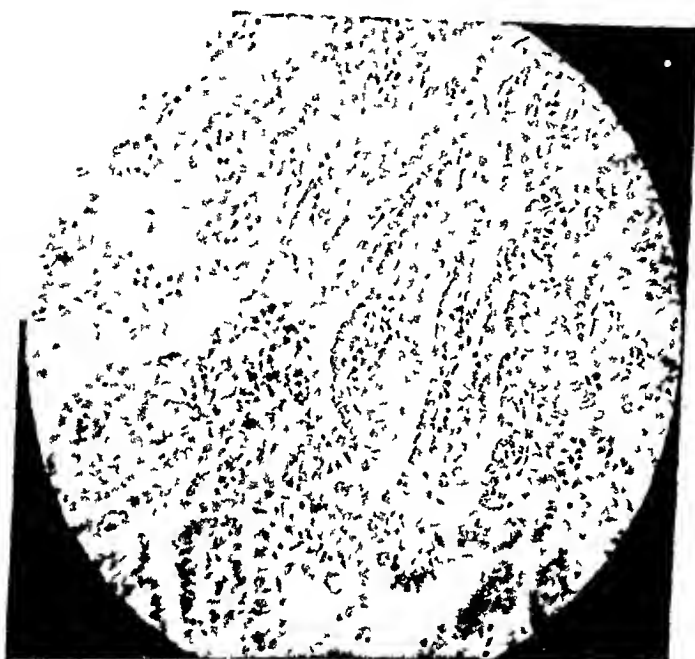


FIG. 2.—High power view of tumor showing the formation of papillae.

times formed vesicles which did not contain colloid. More often they had a papillary arrangement around a central core of connective tissue. Occasionally a number of these papillae were contained in one large vesicle (Fig. 2). In a few areas the tumor cells had become much more irregular and stained very deeply, suggesting added malignancy. A severe inflammatory reaction was present and numerous polymorphs in all stages of degeneration were found among the tumor cells. Lymphocytes were also found in abundance. Lymph-glands as well as areas of less well-defined lymphoid tissue, and the surrounding connective tissue were invaded by the growth. No normal thyroid tissue was seen.

DOCTOR OWEN remarked that this case raises the question of the origin of papillary adenocarcinoma in the thyroid region. If one follows the teaching of the standard text-books, it is generally considered to arise in the gland itself, but in this case the thyroid appeared perfectly healthy. The tumor was found at the site of the previous operation and at the actual spot where a portion of the cyst wall had been left behind. One must therefore assume an origin from the wall itself.

CARCINOMA OF THE THYRO-GLOSSAL DUCT

It seemed just possible that they were dealing with a carcinoma of the thyroglossal duct. But in vain had he searched the literature for any record of such a phenomenon. He had come across no single description of any malignant tumor arising in the thyroglossal duct or from a thyroglossal cyst. Delafield and Prudden⁴ suggest that a squamous-celled carcinoma might develop in such a situation and one other author mentions the possibility,⁵ but none describe an actual growth. Nor could he find any example of a papillary adenocarcinoma arising from a branchiogenic cyst. In all the recorded cases the tumor is squamous-celled. Some other origin for our tumor had to be sought.

As long ago as 1857 Schluter¹² described a somewhat similar growth in the side of the neck which had no connection with the thyroid and which he supposed to be derived from an accessory thyroid gland. Madelung,¹⁰ Jores,⁷ Kapsammer⁸ and others describe papillary adenomas and carcinomas which they all attribute to accessory thyroids. A very able account of these tumors has been given by Billings and Paul.² They have collected and analyzed all the recorded cases (34 in number) of aberrant thyroids and the growths arising from them. Papillary cyst-adenoma and carcinoma have been reported fifteen times. Some of these bear a fairly close resemblance to our tumor. Three authors, Kapsammer, Barker¹ and Hinteistoissei⁶ describe partly cystic tumors, the cysts having fibrous walls as in our case. They do not, however, mention the presence of lymphoid tissue in them. Kapsammer's case is particularly interesting for he gives a figure of his tumor, which seems identical with ours except that it was much larger. His tumor was adherent to the thyroid gland, but had otherwise no connection with it.

If one studies these authors a good case is made out for affirming that this type of papillary adenoma or adenocarcinoma always arises in aberrant thyroid tissue. It would seem to originate but rarely, if ever, from the thyroid itself and never from midline embryonic structures such as thyroglossal rudiments. But in this case if one supposes such an origin is to be explained away the cyst which was certainly present before the carcinoma, and in which the carcinoma began. Of course cysts may and do arise in aberrant thyroids but in that case one would expect to find colloid-containing vesicles grouped somewhere in the wall. The vesicles in the sections were extremely sparse, were never arranged in any kind of group and none contained colloid. It might be held that the carcinoma had produced the cyst, but in view of the history and the findings at the first operation this seems scarcely tenable. He fully admits that the histological character of the cells suggests a thyroid origin rather than an origin from embryonic rests, but the clinical course of the tumor points in the reverse direction. He therefore proposed a compromise. He would suggest that tumors of this type take their origin not from the lining epithelium of the branchial or thyroglossal cysts but from the rudimentary thyroid tissue present in their wall. This satisfies the histological conclusions of Kapsammer and Jores with which he was in

agreement, and at the same time accounts for the situation and mode of growth of these tumors and the microscopical findings in the cyst wall

It would be absurd to draw any final conclusions from the study of one case. He brought this material forward in the hope that others will be tempted to follow up the question and look for preexisting embryonic rests in patients with papillary adenoma or adenocarcinoma of the thyroid

REFERENCES

- ¹ Barker Trans Path Soc, 1896, vol xlvii, p 223
- ² Billings, A E, and Paul, J R Bull of the Ayer Clin Lab of the Pennsylvania Hospital, 1925, No 9, p 27
- ³ Brandt, G Deutsch Zeitschr J Chir, 1924, vol xv, p 187
- ⁴ Delafield and Prudden Text-book of Pathology, p 587
- ⁵ Gilman Surg, Gyn and Obstetrics, 1921, vol xxvii p 141
- ⁶ Hinterstoisser Wien Klin Wochenseler, 1888, p 681
- ⁷ Jores Deutsch Med Wochenseler, 1893, vol xix, p 1050
- ⁸ Kapsammer Wien Klin Wochenschr, 1899, vol xii, p 461
- ⁹ Klingenstein and Colp ANNALS OF SURGERY, 1925, vol lxxvii, p 854
- ¹⁰ Madelung Langenbeck's Arch J Klin Chir, 1879, vol xxiv, p 71
- ¹¹ Paul J R Atlantic Med Journal, July, 1926
- ¹² Schluter Dissert inaug Kiliae, 1857
- ¹³ Wenglowski Archiv J Klin Chir 1912, vol xcvi, p 151

POST-OPERATIVE MASSIVE COLLAPSE OF THE LUNG

DOCTORS W P HEARN and LOUIS H CLERT read a paper with the above title, for which see page 54

DR ISIDOR RAVDIN said that from the Bingham Clinic in Boston, Doctor Scott has reported the entire literature on this subject. There is a definite mortality. The cases he had had all got well without bronchoscopic treatment. He had one patient with complete massive atelectasis following operation for chronic appendicitis. He was extremely ill for five or six days. He thought he was too ill to take the chance of any bronchoscopic treatment. The patient got well and in fifteen or sixteen days was ready to leave the hospital. This condition is frequently confused with pneumonia. If the patient shows signs of pulmonary complications, look at the location of the apex beat. It is always deflected toward the affected side in collapse of the lung.

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

Stated Meeting Held October 13, 1926

The President, DR WALTON MARTIN, in the Chair

OBLITERATIVE ENDOANEURISMORRHAPHY FOR TRAUMATIC ANEURISM

DR HAROLD NLUHOR presented a man, now thirty-three years old, who accidentally sustained a perforating wound of the left thigh by a 45-calibre bullet eight years ago. The entry wound was in the lower part of the thigh on its inner aspect, the exit was in the upper part of the popliteal space. After a few days' rest in bed the patient was able to be up and about without symptoms. Two to three weeks after the accident he noticed a pulsating swelling in the popliteal region. The mass gradually enlarged to reach "the size of a plum," after which it remained stationary. At no time were there well-defined symptoms referable to the swelling. Occasionally there was a sense of heaviness in the limb or a tired feeling after a day's work, but the patient was able to pursue an active occupation without discomfort.

Seven days before admission to the hospital there was a sudden seizure of severe pain in the left calf while the patient was walking about. The next day the pain extended to the left foot and toes. Pain grew progressively worse, soon incapacitating the patient. He was unable to sleep for five days before admission to the hospital because of pain. Discoloration of the big toe and then of the second toe was noted two days before admission, the foot and calf became swollen and bluish.

On admission the left leg from the knee down was enlarged, cool, generally bluish and mottled. There were scattered purplish red areas that were more numerous towards the ankle and foot. The first three toes were entirely blue and colder than the remainder of the foot with necrosis of the skin over the great toe and a beginning patch of gangrene on the second toe. The veins of the calf and foot were deeply engorged. A typical aneurism about 12 cm long 6 to 7 cm wide, occupied the popliteal region. Faint pulsation was to be felt in the dorsalis pedis and posterior tibial vessels at the ankle.

Operation was performed directly after the patient was seen at the hospital for it was evident that the gangrene already present in the toes would be rapidly progressive if relief was not given. It appeared to be justifiable to attempt some form of vascular repair, reserving amputation if that did not succeed.

The sac was found to be generally fusiform in shape, the posterior wall globular. Branches of the popliteal nerve were noted along its lateral aspect. The wall was in part greatly thinned out. The contents of the sac were a large old thrombus partly adherent to the deep surface recent clots, and fluid blood. The aneurism appeared to be a purely arterial one. The mouths of the popliteal artery were towards the floor of the sac and were widely separated.

The operation was done with the application of an Esmarch bandage, a procedure which did not appeal to the reporter but was employed to save time at this emergency procedure. A free vertical incision was made. Avoid-

ing the nerves the sac was entered, its contents evacuated, and the two openings of the popliteal artery were shut off from within the sac by chromic gut sutures. The excess of the sac was ablated and the interior then obliterated by three superimposed tiers of chromic gut sutures.

The day after operation the foot and calf were warm, and there was less cyanosis of the toes than before. Except for the blackness of the first three toes the circulation returned fully to the foot and leg in about ten days. The patient left the hospital, walking in comfort, three weeks after operation. He returned two months later for partial amputation of the second toe, the dry gangrene having persisted. There was as well a superficial necrosis of the tips of the first and third toes. These wounds healed in the course of several months. Six months after operation the patient could walk two or three miles in comfort, complaining of pain in the calf after walking greater distances. It is now more than two years since operation. There is no recurrence of the aneurism. Circulation in the leg is normal, although pulsation in the arteries at the ankle cannot be felt. The patient's occupation involves walking long distances, sometimes ten miles a day, which he can do without any symptoms referable to the left leg.

The symptom-free end result in this case in which the popliteal artery was obliterated and reliance placed on the collateral circulation is in striking contrast with the result of a successful embolectomy done in a man whom he also presented. In this contrasting case, an embolus was removed from the popliteal artery about three hours after the onset of symptoms. The embolus was presumably derived from the mitral valve, the cardiac lesion being one of mitral stenosis of several years' standing. There was prompt return of circulation after the embolectomy and normal pulsation of the popliteal artery and of the arteries at the ankle has persisted. Nevertheless there are frequent attacks of pain and vascular spasm in the extremity. It is assumed that they are due to the scar of operation in the popliteal artery.

DR ROBERT T. MORRIS discussed the possibility of a new channel having been constructed in the popliteal aneurism. Doctor Morris had done this once in preference to following the Matas method of closure of the lumen. There had been no leakage in this case and no interference with circulation excepting while the tourniquet was on but the aneurism occurred a year or so later and required ligation.

RESECTION OF STOMACH FOR LYMPHOSARCOMA

DOCTOR NEUBOR presented a man, forty years of age, whose history, he said, and particularly the X-ray findings, offered some suggestive data on the duration of lymphosarcoma.

The symptoms in this man began two years ago. They consisted in pain in the left upper abdomen and eructations of gas. Pain was never severe, and there were intervals of several weeks in which the patient was free from symptoms. A striking feature was the absence of progression in the symptoms. In fact, the patient felt so well at the time of operation that he desired to postpone surgical treatment.

About six weeks after the onset of symptoms a series of gastric X-ray pictures were taken. They indicated clearly the existence of a small ulcer at the greater curvature of the stomach in its mid-portion. Another series at a later date demonstrated the same lesion. A final set taken shortly before operation showed no difference from the original series taken a year before by the same roentgenologist.

The only positive findings in the physical examination was the vague

LATE RESULT OF TRANSPLANTATION OF TOE FOR MISSING FINGER

outline of a mass in the epigastrium. This in addition to the X-ray studies led to the decision to operate, even in the absence of symptoms suggestive of a progressive or of a grave lesion.

At operation, the greater curvature of the stomach was found to be the seat of a soft irregular mass spread as a plaque in its wall. Its limits were not well defined. The transverse diameter was about 6 cm, the vertical, extending into the lesser omental sac, was 4 to 6 cm. In the centre of the mass a small ulcer was felt. Under the impression that the lesion was a simple ulcer of the greater curvature with a surrounding inflammatory reaction, a midgastric resection was done. The lines of resection went wide of the mass at the greater curvature and converged to a limited resection of the lesser curvature. Five layer anastomosis with catgut sutures was employed. The specimen disclosed a punched-out ulcer through the mucosa with a clean base at the muscularis. Its margins were elevated, soft, and continuous with the surrounding tumor mass. The latter occupied and partly invaded the muscularis. The neoplasm did not invade the serosa and reached the mucosa only at the ulcer. The microscopic examination revealed a typical lymphosarcoma, the margin of the ulcer being composed of tumor tissue. The lymph-nodes that were removed were not involved.

The post-operative course was smooth. A series of deep X-ray treatments were given. It is now six months since operation. The patient weighs more than he did before operation and is free from symptoms. An X-ray examination of the stomach indicates approximately normal peristalsis with slight delay in emptying time.

DR CHARLES L. GIBSON spoke of two cases at the New York Hospital, showing sarcoma of the stomach. The first, a male, age twenty-eight years, operated on July 5, 1921, for a perforating sarcoma of the stomach, made a good recovery and was seemingly in good condition for over a year, dying seventeen months after operation. The pathological diagnosis was myosarcoma. The second, a male, age thirty-four years, had pylorotomy performed in April, 1920 for pyloric obstruction. When last seen a year ago he was in excellent condition, had gained much weight and looked and felt exceedingly well. In this case the examination of the gastric contents showed free HCl 68, total acid 90. The pathological diagnosis was lymphosarcoma.

LATE RESULT OF TRANSPLANTATION OF TOE FOR MISSING FINGER

DOCTOR NICHOL presented a child who came under observation in Mount Sinai Hospital in July, 1922, when she was seven years old. Deformities of the fingers of both hands were noted at birth, and also fusion of two toes of the left foot. The hands were useful for ordinary purposes. The right hand presented an interesting problem for improvement of the deformity and of function. The thumb fourth and fifth fingers were normal. Only the proximal phalanx of the index finger with its thickened surrounding tissues was present. The middle finger was totally absent, a short stump of the proximal phalanx about a centimetre long projecting beyond the head of the metacarpal bone. The plan was to transplant the second toe of the right foot with part of the metacarpus in the form of a pedicled graft. The metacarpus and adjacent tissues were to be included in order to supply the necessary length. A few days before operation a plaster-of-Paris mould was prepared to hold the child in position with the right knee flexed and the right arm extended downward in front of the body.

At operation the stump of the missing finger was first prepared. The

overlying skin was reflected as a flap with its base on the ulnar side. The shell of proximal phalanx, found to be of cartilaginous consistency, was exposed and its end freshened. The stumps of the flexor and extensor tendons of the missing finger were exposed and dissected free for a distance of about 2 cm. A wet pack was put in place and dissection of the foot begun. This consisted in an incision across the web between the first and second toes and extension of the incision over the dorsal and plantar surfaces of the foot. The head of the second metacarpal and the flexor and extensor tendons of the second toe were isolated and were divided about 1.5 cms back of the head of the bone. The tissues on the lateral aspect of the second toe were not disturbed, so that the toe with adjoining metacarpal bone and tissues swung on a thick pedicle with undamaged lateral nerve and blood supply. The hand and foot were then brought together by rotating the right leg and bringing the shoulders forward. More difficult was the problem of adjusting the fingers to the foot. The thumb and second finger were placed on the dorsum of the foot, and the fourth and fifth fingers over the sole of the foot. After the hand and foot were placed and held in position, the stump of the finger was approximated to the pedicled toe. A suture of chromic gut was passed through the shell of the phalanx of the missing finger and through the metacarpal bone and tied without tension. The ends of the extensor and flexor tendons of toe and finger were approximated with fine silk. The margin of the skin flap of the finger was sutured to that of the toe. Immobilization in plaster-of-Paris casing.

In recovery from the anæsthetic the child struggled and the plaster shifted. Some separation of the skin was noted on the third day, and it was necessary to use adhesive straps to maintain approximation of the skin. The circulation in the pedicled toe remained good.

The detachment of the toe was carried out fifteen days after the first operation. An incision was made across the web between the second and third toes and extended wide of the second toe, so that there would be more skin than was necessary. The space in which the dissection was made was cramped and the tendon anastomoses were damaged when the toe (with adjoining metacarpal tissues) was completely detached. It was necessary to remove much of the fat pad on the plantar surface and part of the metacarpus of the transplant because these structures made too pronounced a prominence for a cosmetic result. The skin margins were trimmed and sutured.

The circulation remained good in the graft from the outset. The wound healed by primary union for the most part. Sensation was first noted in that part of the graft nearest the finger stump about three weeks after detachment. It advanced in ring-like fashion and sensation was normal about six months after operation.

There were never any symptoms referable to the transplanted toe. About six weeks after operation it appeared certain that the tendon sutures had not held. Every effort was made to have the parents consent to send the child to the hospital for resuture, but I was unable to obtain their consent. The first winter after operation the transplanted toe was colder and more bluish than the adjoining fingers in cold weather. These manifestations have disappeared since that time. The only disturbance in nutrition of the grafted toe is to be noted in the nail. This grew irregularly at first. Now it grows smoothly but more slowly than the normal, and the free margin of the nail breaks off from time to time. The function in the transplant is limited to movements transferred to it by the adjoining stump of the finger and separate motions can only be anticipated if the tendons are sutured or a tendon transplant performed. The X-ray pictures show not only survival of the phalanges,

CARCINOMA OF ASCENDING COLON

but also indubitable evidence of increase in length and thickness. This is most clear in the proximal phalanx of the grafted toe. At no time after operation in a period of a year during which numerous X-ray pictures were taken was there any evidence of absorption of the phalanges with bone replacement, the phenomenon that I had anticipated. There has been and there continues to be a slowly progressive increase in the length and thickness of the transplanted toe. Four years have elapsed since the transplantation has been done and there is therefore every reason to expect permanent survival of the graft. The cosmetic result is satisfactory but not of course ideal for a transplanted finger would alone fulfill all the requirements.

CARCINOMA OF ASCENDING COLON

DR CHARLES L. GIBSON presented a man, aged twenty-five years, who had been subjected by him to appendectomy in January, 1925, and to right hemiotomy and hemiorchidectomy in October, 1925. From the date of the latter operation his health was poor and he lost flesh and strength and suffered a good deal from abdominal pain and increasing constipation.

When admitted he looked acutely ill and very anæmic. Two-inch scar to right of umbilicus. To the right of the scar there was a hard, irregular mass somewhat larger than a fist evidently in the colon. Bismuth picture of colon showed a persistent filling defect of colon. Prior to operation a blood transfusion was done.

At operation, June 11, 1926, a carcinoma of ascending colon was found. A resection was done with line of section through the ileum, a foot from the valve and the middle of the transverse colon. Anastomosis end-to-side with Murphy button, Murphy button being introduced through the suture line of the colon and made to protrude through the gut by Carle and Pantano technic.

He had a difficult convalescence. Two weeks after operation another 800 cc transfusion given after which improved rapidly. Discharged on the twenty-sixth post-operative day in excellent condition.

It is now four months since operation. He has gained fifty-nine pounds in weight.

DOCTOR GIBSON said that he presented this case to show the disadvantages of an appendectomy through a small incision, not allowing of proper exploration. For some years he had both practiced and preached that every operation for chronic appendicitis should be an exploratory operation.

There is every reason to think that the tumor was present at the time of operation and was the source of the symptoms for which an appendicitis was mistaken.

He called attention to the advantages of the technic used in this case—a fairly rapid and satisfactory operation—the use of the Murphy button for end-to-side anastomosis between the ileum and large intestine. The large intestine is closed by running suture of catgut of the mucous membrane first. The last two or three loops are left loose allowing of the dropping of the button into the lumen of the gut, the suture then is pulled tight. Then follow the two other layers of sutures. After the colon has been closed the shank of the Murphy button is made to protrude very close to the line of closure. It is very important to have no dead space in the closed colonic end. The Murphy button so employed is readily introduced, is absolutely safe and easily passes into the small intestine.

CANCER OF TONGUE

DR GEORGE H SEMKEN presented two patients who illustrated different methods of operation in cancer of the tongue anterior to the vallate papille, in which the primary tumor has apparently not extended beyond the limits of the tongue

The first patient, a woman, aged thirty-one, came under observation December 29, 1924. Two months previously, she had noticed a small lesion under the left side of the tongue, which apparently had been caused by the sharp edge of one of the lower teeth. The lesion was an irregularly elliptical ulcer, 1.5 cm in its long diameter, with considerable induration at its base. It caused no discomfort except on contact with food. The submaxillary lymph-nodes on both sides were slightly enlarged, but those on the left more markedly. The family history showed no known antecedent cases of cancer. The remaining previous history was irrelevant, and the Wassermann reaction was negative. No etiologic factor for cancer, other than the sharp tooth could be found.

The operative procedure in this typical case was planned to remove the lesion and its presumable extensions in the tongue, together with the regional lymph-nodes as charted by Kuttner [*Beitrag zur Chirurgie*, 1898, vol. xvi No. 3, p. 732]. This involved the removal of the left half of the tongue with part of the left hyoglossus and genio-glossus muscles, all the lymph node groups on the left side of the neck, the lymphatics of the upper half of the right side of the neck and those of the submental space. The operation was done in two stages. On January 2, 1925, the submental and upper right-sided neck dissection, and the intra-oral left hemi-glossectomy were done, and on January 30, 1925, the dissection of the left side of the neck followed. The pathological laboratory examination of the specimens showed squamous-celled carcinoma in the tongue and hyperplasia alone in the lymph-nodes. The present anatomical and functional conditions are good.

The second patient, a man, aged sixty-one years, came under observation April 5, 1926. He had had a coated tongue and occasional soreness since three or four years, but no lesion had been noticed until about six weeks previously, when a nodule of pin-head size appeared on the dorsum of the tongue at the tip. The nodule broke down, leaving a small hole, and this excavation became progressively and rapidly larger. At about the same time (relatively) a mass appeared on the right border of the tip, and this also increased rapidly in size. Both lesions were very painful. At the time of examination he had a midline, hard infiltration in the tip of the tongue 3.0 x 2.2 cm in diameter, with a longitudinal excavation 2.0 cm long 0.7 cm broad, and 1.2 cm deep which reached to the under surface. The floor was clean and red. In addition, he had a nodular infiltration in the right edge of the tongue, 1.6 x 1.4 cm in diameter, near the tip. It extended through the whole thickness of the tongue and showed on the dorsum as a fungoid rounded projection with spots of yellow and gray. The chief node of the right submaxillary group was enlarged and hard. The family history showed no known antecedent cases of cancer. He had been an excessive pipe smoker and formerly also chewed tobacco. He had had syphilis thirty-five years previously, but was Wassermann negative. The previous history otherwise was irrelevant.

Under treatment with potassium iodide, he seemed to show some improvement, but this was soon followed by an increase in the extent of the lesions with evidence of considerable and destructive invasion. The midline lesion, 3.5 x 1.3 cm, split the tongue and gave it a forked appearance, and its floor

CANCER OF THE TONGUE

became fungoid and necrotic. A similar advance was noted in the lesion in the right edge.

The operative procedure in this case consisted in the removal of the tongue to the zone just posterior to the vallate papillæ with the hyoglossus and genio-glossus muscle, all the lymph-node groups on the right side of the neck, the submental group, and the upper lymph-node groups of the left side of the neck. This operation also was done in two stages. On April 29, 1926, the lymphatics of the upper half of the right side of the neck and of the submental space were removed, the lingual artery was tied, and the hypoglossal nerve and the lingual branch of the fifth nerve were divided. The anterior tongue was then excised through the mouth, together with as much of the hyoglossus and genio-glossus muscles as could be removed by this route. On June 5, 1926, the operation was completed by the removal of the upper left cervical lymphatics, and the remaining (supraclavicular) lymphatics of the right side of the neck. The pathological laboratory examination of the removed tissues showed squamous-celled carcinoma in both lesions of the tongue and hyperplasia in the lymph-nodes. The present anatomical and functional conditions are good.

DOCTOR SEMKEN said that in hemi-glossectomy for cancer certain technical points deserve emphasis. (1) If the line of section is exactly median, the remaining half of the tongue will have a relatively sharp, long, narrow, tip, which has little mechanical value, and which is constantly traumatized by the anterior teeth against which it impinges. It is preferable, therefore, to extend the incision across the tip of the opposite (healthy) half so as to include enough of its tip in the excised tissue, to leave a rounded end on the remaining tongue tissue. (2) If the line of section is exactly median, also, it will go through the raphe and may fail to remove some of the small lymph-nodes situated in this part of the tongue. This danger is obviated by carrying the longitudinal line of section along the opposite half, slightly to the side of the median line. (3) In order to include as many large trunk lymphatic vessels of the tongue as practicable, the decussating lymphatic plexus about the apex of the vallate papillæ is included by having the line of section sweep around that point, and, further, in suitable cases, the lower pole of the tonsil of the same side and the tissue just below it, are included in the tissue removed. (4) The removal of as much of the hyoglossus and genio-glossus muscles as can be done from within the mouth is designed to include the possible extrinsic extensions of cancer in that direction, as shown by Cheatle (*Practitioner*, 1905, vol lxxv, No 5, p 623), and others. (5) An important measure of safety is the preliminary destruction of the surface of the cancerous ulcer with the actual cautery, to guard against possible re-implantation of cancer during the operation, especially by trauma from the gauge wipes. (6) The landmarks on the tongue, floor of the mouth and fauces are readily visible under ordinary conditions, but become obscured by even a small amount of blood in the mouth and throat. This obscuring of the landmarks tends to make the lines of incision uncertain, and too little or too much tissue may be removed or the cancer field itself may be entered. To guard against this uncertainty a series of black silk suture guides may be inserted at landmark points before the operation.

is begun. These will remain readily visible in spite of blood and mucus, and incisions carried around the line of guide threads, so as to leave them all attached to the tissue that is removed, will safely circumscribe the intended field of excision. (7) In the few cases in which the lymphatic dissection in the neck is done on the same side as that of the cancer of the tongue at the primary operation, the ligation of the lingual artery of that side reduces the bleeding during the hemi-glossectomy. In the typical procedure, however, the upper lymphatics of the opposite side are removed in the first stage, and it is not safe or desirable to ligate the lingual artery of the healthy side. As an effective alternative measure, a catgut ligature may be placed around the external carotid artery of the healthy side, just distal to the superior thyroid branch. This is left untied, with the long ends emerging between sutures of the closed neck wound, and the angulation closure of the external carotid by traction upon these long ends during the incisions in the healthy half of the tongue gives the required control of the bleeding in that area. The ligature is withdrawn at the end of the operation and the artery remains uninjured. In sectioning the remaining tongue substance, across the region posterior to the vallate papillae, the Bunk haemostatic, crushing forceps is of considerable value.

The subtotal glossectomy is larger in its extent than the hemi-glossectomy, but is less difficult technically because the early division of the hyoglossus and genio-glossus muscles of both sides near the hyoid attachment, makes it possible to draw the root of the tongue far forward and facilitates the sectioning of the tongue in this region. As in the case of hemi-glossectomy, the preliminary cauterization of the surface of the cancer, the use of black thread suture guides, and the precaution against undue bleeding are important factors. In addition, it is important also to grasp the stump of the root of the tongue with traction sutures while the section of this region is being made to prevent it from dropping back into the hypopharynx. To avoid confusing these sutures with the landmark guide threads, a different material, preferably linen thread, is used for the traction sutures.

In both hemi-glossectomy and the subtotal resection, it is desirable to have the mouth wound completely closed by suture. In the hemi-glossectomy, the remaining tongue segment is rolled over so that the former lateral border becomes the new dorsum, and the cut dorsal mucous membrane is sewed to the floor of the mouth. In the subtotal glossectomy, the mucous membrane of the floor of the mouth can be sutured to form a new floor over the gap in the midline. The suture material is fine silk (No. 1) or fine chromic gut (No. 0 or 00), and three knots are used instead of two, because of the tendency of these sutures to become untied in this moist area.

Fluid is given per rectum during 24 to 48 hours after operation, and then *via* the Einhorn tube with the Rehfuß tip, which may remain in place until the healing is sufficiently advanced to make swallowing safe. By means of a small catheter introduced through a nostril, the end of the Einhorn tube may be led out through the nostril, and its presence there causes a minimum of discomfort.

CANCER OF THE TONGUE

In dividing cancer operations upon the tongue and neck into stages, it was formerly the standard practice to dissect the neck lymphatics, ligate the lingual artery and divide the tongue nerves in the first stage, and to operate upon the tongue ten to fourteen days later. This plan had its merit in furnishing the most favorable technical conditions in each operating field, first through the absence of marked inflammatory changes in the neck, and second, through the diminution in size and in vascularity of the tongue cancer, in the interval between the operations. Infection of the neck wound was less likely to occur if the mouth cavity remained unopened by operation. As a cancer procedure, however, this plan has been recognized as inadvisable and probably unsafe. The tongue cancer is the potential starting point of metastases, and in spite of the regressive changes following the ligation and the nerve section, it may continue to send metastases through the lymph channels into the neck wound, and other metastases may travel along unrecognized collateral lymph-vessel routes. This danger is increased if post-operative complications in the neck, or pneumonia, or the poor general condition necessitate the postponement of the second operation. From the cancer standpoint, therefore, the best plan of procedure involves the removal of the tongue segment with the primary cancer as part of the first stage, following up the regional metastases "centrifugally" in one or more stages.

The regional lymphatics of the tongue have been carefully studied and charted by Kuttner (*loc cit*), Poirier ("The Lymphatics," Poirier, Cuneo, Delamere and Leaf), and Jameson and Dobson (*Brit Jour Surg*, 1922, vol. viii), who are in substantial agreement as to their distribution and extent, and their findings are borne out by the course of the metastases in clinical observations. To what extent and in what order the lymphatics should be removed in cases of cancer of the tongue, constitutes one of the important problems in cancer surgery. Some tongue cancers have been treated by excision of the tongue segment alone, and have remained well, but the unreported cases in this group that had recurrences in the neck are much more numerous. Metastatic cancer begins as a microscopic focus that cannot be palpated. In another group, a limited lymph-node removal has been done, and the microscopic examination of the nodes (done in the usual manner, without serial sections), showed hyperplasia alone, nevertheless, cancer recurrence appeared in the lymphatic region beyond the region excised. In any given case, it is obviously impossible to determine clinically (1) that there has been no lymph-node metastasis and (2) to what limits the metastasis, if present, has gone. It seems logical, therefore, to adopt the maximum as the standard procedure, and limit the scope of the excision in individual cases. In unilateral tongue cancers without demonstrable extension beyond the tongue, the submental nodes and the nodes of the "healthy" side of the neck are removed, from the mandible and the jugular fossa above to the level of the omohyoid crossing of the internal jugular below, including the broad lymphatic field posterior to the vein in the first operation. The tongue segment is removed at the conclusion of the neck operation. The conditions for the healing of the neck wound are thus very favorable, since

leakage from the mouth cannot occur. The second operation may be postponed for two to four weeks, and it is advantageous to allow the patient to be out of the hospital for a week or ten days before the second operation is done, to improve his general condition. The second procedure involves the removal of all the lymphatics of the "diseased" side of the neck, from the mandible and the jugular fossa down to the clavicle. Experience has shown that it is not safe to operate upon both sides of the neck at one operation.

In cases in which the cancerous process is in the midline, involving both sides of the tongue, a similar extent and sequence may be followed, but it would seem safer to remove the whole lymphatic field on both sides. The supraclavicular region of the side included in the first operation may be left for a third step if necessary.

Variations in this sequence may be required for patients who are difficult to control and for those whose condition precludes extensive surgical interference, but the principle of removal of the primary tumor at the first operation and "centrifugal" progressive lymph-node removal seems essential.

When there has been demonstrable extension of the tongue cancer upon the floor of the mouth, or when there is demonstrable lymph-node cancer, new problems are presented by the necessity of splitting the jaw, removing the tumor and the nodes in one block, or removing node masses in different groupings—and the solution of these is individual for each given case.

Colonic ether anaesthesia and the prophylactic use of a hypodermoclysis of Ringer's solution with adrenalin during the operations have proven valuable aids.

THORACOTOMY IN BREAST CANCER

DOCTOR SEMKEN said that at the meeting of the New York Surgical Society held November 28, 1923, a case of resection of a segment of the chest wall for localized cancer was presented, that had remained well for two years and eight months following the operation (*ANNALS OF SURGERY*, 1924, vol lxxix, p 461). That patient is still free from recurrence, five years and seven months after operation. He now presented a similar case done in the same year, and also free from recurrence for over five years.

The woman, aged fifty-one years, came under observation May 9, 1921. Eleven years previously, a radical operation for cancer of the right breast had been performed at a hospital in New York City, and she had remained well until a few months previously, when a stony hard, pink, nodular mass appeared on the right chest wall in the region of the fourth rib at the scar from the earlier operation and posterior to it. It was a typical cancerous mass 4.5×2.0 cm., involving the skin and subcutaneous tissue, with fixation to the rib and the intercostal muscles (Fig 1). No other metastases were demonstrable.

May 17, 1921, under colonic ether anaesthesia, the skin about the tumor was widely circumscribed, and the incision was extended upon the arm and down upon the midline of the epigastrium. The old scar was included in the removed tissue, thin skin flaps were reflected, the axilla and subscapular space were carefully cleared, the epigastric fat, upper anterior rectus sheath and the fascia over the serratus were removed, together with the fat and muscle tissue remaining upon the ribs and intercostal muscles, the dissection progressing from the periphery toward the tumor as a centre, and finally a segment

THORACOTOMY IN BREAST CANCER

of the chest wall consisting of 80 cm of the fourth rib with adjacent intercostal muscles, overlying tumor, and underlying pleura was removed—all in a block dissection. The opening of the chest cavity caused no respiratory embarrassment and only a partial collapse of the lung. It was covered at once



FIG. 1.—Recurrent carcinoma of the chest wall eleven years after radical operation for cancer of the breast case Mrs. M. S.

with a moist warm towel and the wound was closed. The arm and upper chest wound was sutured. The defect in the chest wall was covered with a large sliding flap of skin and subcutaneous fat from the upper abdomen, and the defect at this site was closed with a Thiersch graft. In the post-operative course some uneasiness of mind was caused by necrosis at the tip of the flap,

but this did not extend far enough to endanger the closure of the chest defect. No respiratory difficulty occurred at that time or since then, and the patient is apparently in excellent health, five years and five months following the operation (Fig 2)

The microscopic examination of the removed tissue was reported by Dr F D Bullock as follows "The microscopical examination shows an epithelial growth which involves the skin and underlying tissues, the inter-



FIG 2 —Sliding flap closure of the defect in the chest wall late result case Mrs M S

costal muscles, and the rib. Tumor elements are observed in some of the medullary spaces of the rib, and the growth has reached the under surface of the rib by penetration of the intercostal muscles. The tumor cells are small and contain relatively large, round, hyperchromatic nuclei. They are polyhedral or irregular in shape and are arranged in narrow columns or strands, small groups or larger islands, or they form the lining of irregular spaces. No well-defined acini are noted, and mitotic figures are seldom observed. The stroma is abundant and is for the most part acellular and cicatricial, though in areas it is fairly cellular.

PARALYTIC ILEUS IN APPENDICITIS

Diagnosis Small-celled carcinoma of the thoracic wall with involvement of the rib "

PARALYTIC ILEUS AS A COMPLICATION OF ACUTE APPENDICITIS

DR GUILFORD S DUDLEY read a paper with the above title, for which see vol lxxxiv, p 729, December, 1926

DR CHARLES L GIBSON stated that his experience with jejunostomy was very limited and that the few cases in his service at the New York Hospital which had been performed under conditions which Doctor Dudley had pointed out, had offered little prospect of usefulness having been done as a last resort, usually yielding to the urging of the family to exhaust every possibility

Many cases have been seen with a marked peritonitis which might have been treated as the essayist has described, yet they recovered entirely without this measure

The case for jejunostomy is still on trial and while it has its enthusiastic partisans there are a good many experienced surgeons to whom it does not appeal The operation of jejunostomy itself, even if skilfully done, is a complication, and it is quite possible that some of the fatal cases might have succumbed as much to the effects of the jejunostomy as to the peritonitis These patients do not die of an intestinal obstruction, that is, in cases of paralytic ileus without mechanical complications, they die of peritonitis, and if we can bring the peritonitis to an end most of these patients would recover

Of recent years, our policy has been directed toward the arrest of the peristalsis and, rather than administering cathartics or intestinal stimulants such as pituitrin, giving the patients plenty of morphine, emptying the gastrointestinal tract with frequent lavages and the introduction of fluid by the rectum, under the skin or even intravenously Under these measures with confidence in them and patience it is remarkable how in many desperate cases the storm will blow over and eventually recovery will take place

Much enthusiastic work has been done in regard to acute intestinal obstruction and most of it has been directed toward the search for a lethal factor in the intestinal contents It is quite possible, even probable, that the source of trouble does not lurk in the intestinal lumen, but in the intestinal walls By analogy we must remember what happens in the gall-bladder Very often an acute inflammation of the gall-bladder will yield only a sterile culture of this condition, but active bacterial processes are found in the walls of the viscus

DR SEWARD ERDMAN said that in the series of over seventy cases of jejunostomy 42 per cent had recovered The majority of these patients had been operated upon on the Second Surgical Division of the New York Hospital A study of this series had convinced Doctor Erdman that jejunostomy has a very definite value in the treatment of mechanical ileus, though he does not feel that it is of any great assistance in cases that show actively progressive general peritonitis He believed that the ileus which is apparent during the first four or five days of an acute general peritonitis is to be considered

purely of the toxic or paralytic type, but that after the first five to seven days of a septic peritonitis the ileus is frequently due to adhesion of loops of bowel with kinking and obstruction

The best results in the application of jejunostomy, therefore, have been obtained in those cases in which jejunostomy was performed later than the fifth day of the disease, although in many instances this time period may correspond with the time of the operation for appendicitis or follow it within one or two days. Doctor Eidman said that the average length of time for keeping the tube in the jejunum was from four to six days, and there was seldom indication for a longer period. He believed that the difficulty which some operators had with persistent duodenal fistula was due to making too large an opening or, more probably, to too long-continued drainage. In his own experience thirty-two patients had survived this operation, and in only two instances was a secondary procedure necessary to close the fistula, both of these were in children, aged eight and ten years, where the abdominal parietes were very thin, and also both were cases early in the series when the drainage had been unnecessarily prolonged. In all of the remaining thirty cases the fistula closed spontaneously with practically no leakage.

DR ROBERT MORRIS disapproved of jejunostomies in cases of paralytic ileus after appendicitis operations. He believed that this form of paralytic ileus seldom occurred unless the appendicitis operation had been unnecessarily severe. This feeling was based upon the observation that ileus seldom occurred in olden times in the practice of physicians who refused to have appendicitis patients operated upon.

Furthermore, it was an extremely frequent complication at the height of the Third or Pathological Era of surgery when surgeons conscientiously felt that they must be very thorough in removing microbes and their by-products and inserting masses of gauze or other large drainage devices.

Surgery is now gradually merging into the principles of the Fourth or Physiological Era in which the natural resistance of the individual is conserved. As a corollary we now see much less of paralytic ileus following appendicitis operations than we did twenty years ago.

Handley's method and other jejunal operations are theoretically correct on the basis that virulent poisons really are found in the upper bowel in the presence of stasis. Practically, however, many vicious paraenteral organisms may be found in the free peritoneal cavity in these cases. Jejunostomy operations may perhaps intensify their activity.

So many ileus patients made good post-operative recovery after employment of the Murphy method or the Ochsner method, one or both combined that the speaker would hesitate about introducing a serious surgical operation in a class of patients who at the time are not at all in condition to withstand the shock. Older and more conservative methods seemed to give much better statistics than are now being reported by surgeons who are trying out jejunostomy.

PARALYTIC ILEUS IN APPENDICITIS

DR ALEXIS V MOSCHCOWITZ remarked that he could not fully share the enthusiasm of Doctor Dudley regarding jejunostomy. It is exceedingly difficult to evaluate the results of the operation because while the operation is usually done in very desperate cases, no one can tell whether or not the patient would have recovered even without jejunostomy. Some of the junior staff on his service find indications for this operation much more frequently than he does, therefore, he has sufficient experience with the operation and its results. Personally, Doctor Moschcowitz is of the opinion that patients who get well do so not because of jejunostomy, but in spite of it.

DR FREDERIC W BANCROFT said that all agreed that immediate post-operative rest of the gastro-intestinal tract is advisable to prevent the spread of peritonitis and the production of ileus. There was, however, one prophylactic method that he thought had not been given the attention it deserved. He referred to the Levin tube. These tubes are made in three sizes for children, young adults, and adults. They are modified duodenal tubes. They are inserted through the nose into the stomach at the time of operation and are connected at the side of the bed to a bottle. The patient is then allowed to drink water which immediately returns to the stomach through the tube.

During the last six months, Doctor Bancroft and the Surgical Staff at the Lincoln Hospital had used this method, and feel that it cuts down post-operative vomiting entirely, and saves the patient from frequent lavages. He believes that lavages and vomiting are associated with spasmodic heaving of the diaphragm, therefore must tend to spread peritonitis and aid in the production of ileus. It is his opinion that the use of this tube may prevent the necessity for a jejunostomy.

DR FRANK S MATHEWS referred to recent statistics of the two surgical divisions at St Luke's Hospital, on one of which enterostomies following appendicitis are moderately popular, and on the other division not employed. In the last year and nine months on the division employing ileostomy, the mortality has been $7\frac{1}{2}$ per cent, there being eight ileostomies with five deaths. On the division not employing it, the mortality has been 6 per cent. The only inference that could be suitably drawn from this series of over three hundred cases would be that the introduction of ileostomy has not corresponded with statistical improvement. Doctor Truesdell, of St Luke's, last year reported his appendectomies in which there were no ileostomies, and his mortality was less than 5 per cent. The speaker had looked over thirty-nine recent consecutive acute appendix cases of his own in which there were two deaths. Neither of these were cases that could have been influenced by enterostomy. He did not wish to say that no case of acute appendicitis with ileus would be benefited by ileostomy, but with our present very low mortality in acute appendicitis he thought that the cases in which it is indicated are very few, and it was his impression that in some hospitals it is being done much too frequently.

BRIEF COMMUNICATIONS

RELIEF OF POST-OPERATIVE MASSIVE COLLAPSE OF THE LUNG BY BRONCHOSCOPIC ASPIRATION

TUCKER has recently reported two cases of post-operative massive collapse of the lung in which bronchoscopy with the aspiration of thick tenacious secretion caused immediate relief from symptoms, and restoration of the



FIG. 1.—Initial roentgenogram showing massive collapse of the left lung and marked displacement of the heart and mediastinum

displaced heart and mediastinum to normal position. He believes that the collapse of the lung was caused by bronchial blockage from thick secretion and absorption of air beyond the point of obstruction and accumulation of fluid, as is seen in certain cases of foreign body impacted in a bronchus.

There may be other factors in the production of this so-called pulmonary collapse. One factor that has received scant consideration is the post-operative posture of the patient. Webb, Forster and Gilbert have shown that if a normal person is

placed on the right side for an hour there is marked displacement of the heart and mediastinum to the right with atelectasis of the right lung. When there is normal postural deviation of the mediastinal structures, it is easy to understand how, immediately after operation, stagnation of the secretions on the compressed side with respiratory embarrassment may develop. The case presented here supports the latter hypothesis and shows the value of bronchoscopic aspiration of the retained bronchial secretion.

A man, aged twenty-eight, was operated on August 11, 1926, for removal of a large infected hydronephrotic right kidney. Ether anesthesia was employed. The operation was long and difficult because of firm perinephritic adhesions. After the operation the patient was placed in bed on the left side. The following morning he noted a burning sensation beneath the sternum and in the afternoon a very severe pain in the left side.

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RELIEF OF POST-OPERATIVE MASSIVE COLLAPSE OF LUNG

FIG. 2—Twenty-four hours after first roentgenogram showing marked increase in density



FIG. 3—Examination of left lung showing marked clearing of left lung immediately after bronchoscopic aspiration, with restoration of heart and mediastinum to normal position



of the chest. The temperature rose to 102° , the pulse rate to 110, respirations were 28. There was moderate cyanosis. The leukocytes numbered 7300.

Physical examination revealed displacement of the heart and mediastinal structures toward the left side, and marked diminution of breath sounds over the lower lobe of the left lung. Rontgen-ray examination revealed massive collapse of the left lung, and the heart and mediastinum pushed markedly toward the left (Fig 1). The patient remained about the same for twenty-four hours, when dyspnoea and cyanosis became marked and the respirations were 48. Death seemed inevitable. The leukocytes had



FIG 4 —Condition of patient at dismissal

dropped to 4400. Rontgen ray examination showed an increase in density over the left side of the chest (Fig 2). Bronchoscopy was then performed under local anesthesia, and on the introduction of the tube a thin serous secretion poured out of the trachea. About 300 cc of fluid was aspirated from the left lung. There was severe tracheobronchitis. Although all of the secretion seemed to come from the left lung the consistency was not thick, as in cases observed by Tucker. The dyspnoea and cyanosis subsided immediately after aspiration of the fluid, a rontgenogram made fifteen minutes afterward showed the heart in normal position and marked decrease in the pulmonary density (Fig 3).

Recovery from this time on was entirely uneventful, and the patient was able to leave the hospital on the sixteenth day. At the time of dismissal the rontgenograms of the chest revealed nothing abnormal (Fig 4).

DRS JAY R. COFFEY and PORTER P. VINSON were associated with the reporter in the care of this patient.

BIBLIOGRAPHY

- ¹ Tucker, Gabriel. Recent Developments in Peroral Endoscopy. Esophagoscopy and Bronchoscopy for Disease, Report of Cases. Surg, Gynec and Obst, 1926, vol XLII, pp 743-752.
- ² Webb, G. B., Forster, A. M., and Gilbert, G. B. Jour Am Med Assn, 1921, vol XLVI, pp 846-849.

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TERATOMA TESTIS WITH METASTASIS

A man, aged thirty, was admitted to the National Military Hospital at Sawtelle, Cal., January 5, 1926, complaining of pain in the back and across the upper part of the abdomen. There was a large mass in the abdomen, also a lump in the scrotum.

TERATOMA TESTIS WITH METASTASIS

He dated his present illness back to August, 1925, at which time he was forced to quit work. In September, 1925, at the Tacoma General Hospital, he stated that a tumor mass was found in his abdomen.

On admission at the Sawtelle Hospital the pains across the lower part of his back were practically continuous, sharp at times, at others dull and aching in character. They radiated from one side of the back to the other. Occasional similar pains across the upper abdomen were severe only after the manipulation of an examination. There had been some nausea but no vomiting. He had to take a cathartic every other day.

In January, 1924, there had been swelling, redness and soreness in the left testicle. There were no chills, but he thought he had some fever and he "felt badly all over." The swelling subsided every evening when he got off his feet. He could recall no trauma. Ten days later the condition had entirely cleared up. Three months later he noticed, for the first time, "a small, hard knot about the size of a large pea in the left testicle." It was not tender. The mass gradually increased in size until, at the time of admission here, it measured six by four centimetres. It had never been painful.

His weight and strength had held up well until August, 1925, since then there had been a gradual loss in both until he could scarcely walk across the room because of weakness and the pains in the back. He was poorly nourished, weighing 122 pounds (normal weight 158 pounds). The knees drawn up because this position relieves the pain in his back, especially of the left side. Moderate exophthalmos. The pupils round and equal, but react sluggishly to light. No pathology in the fundi.

There is moderate dilatation of the superficial veins of the chest. The superficial veins of the abdomen moderately dilated, more on the left. A large, firm, fixed, irregular, tender mass in the upper right quadrant, palpation of which makes the patient, "sick all over." The left testicle is hard, irregular, not translucent and not abnormally tender, and freely movable in the scrotum. Kernig 160 degrees right and left. Deep reflexes equal and hyperactive, the abdominalis absent. Slight tenderness in the lumbar and sacral regions, and bending backward causes pain.

Temperature subnormal, pulse 100, regular in force and rhythm. A trace of albumin in his urine. The blood findings: Hæmoglobin (Dare) 57 per cent, erythrocytes 4,024,000, leukocytes 9000, polymorphonuclear neutrophils 75 per cent, lymphocytes 18 per cent, transitionals 6 per cent, myelocytes 1 per cent, Wassermann negative.

X-ray Findings—The dorsal, lumbar and sacral spine show no positive evidence of injury or disease. Chest, both bases show marked annular, well circumscribed discrete shadows extending as high as the second interspaces. The lungs above and surrounding these areas show fairly good aeration. The apices are clear. Evidence of secondary metastasis. Gastro-intestinal tract, in conclusion, malignancy of the antrum, first portion of the duodenum, indirect evidence of malignancy of the liver.

He died January 26, 1926.

Autopsy—Pleuræ adherent to chest wall most marked at the bases. Lungs interspersed with many grayish-white tumor masses well defined and regular in outline, varying in size from one and one-half to five cm in diameter, more numerous at the bases. One of the larger ones showed necrosis. The liver a third larger than normal. Scattered through its substance numerous sharply defined regular grayish-white tumor masses ranging in diameter from one to four cm. The larger of these tumor masses showed necrotic changes.

The recto-peritoneal glands formed an irregular tumor mass extending along the left iliac vein from Poupart's ligament well up into the upper left quadrant, and across the midline in practically its whole extent. Two-thirds of the mass necrotic.

The left testicle measures five by three and a half cm. On section the lower pole made up of a rounded mass two and a half by two and a half cm containing yellow caseous material.

The microscopical findings by Dr Frank Sturdivant, Pathologist of the Pasadena General Hospital "Sections from the testicle The primary tumor in the testicle shows areas resembling typical carcinoma of the ducts, epithelium of the squamous type in islands, small areas made up of cartilage cells, and larger areas of degeneration Sections from the liver show a metastatic tumor It is entirely epithelial in character Sections from the lung The character of the cells in the metastatic tumors of the lung are, also, epithelial in character Diagnosis Teratoma testis, embryonal in type, with metastasis to the liver and lung This is the usual site of metastasis of this tumor"

Sections sent to Dr Frank Hinman* brought this reply Sections of the testicular tumor show a confusion of structures, all more or less embryonal in character, representing all three germ layers Most of the stroma is composed of rather embryonal connective-tissue cells Occasional cells are seen that suggest nerve fibres Smooth muscle cells are present in small numbers Masses of cartilage, varying in structure from embryonal to adult types, are rather numerous Ectoderm is represented by islands of squamous epithelium and by small cysts lined by squamous cells Some of these islands show marked cornification Many glandular structures of entodermal origin are present Some of these have undergone malignant changes and carcinomatous areas are present everywhere throughout the sections These carcinoma cells show relatively little variation in size and shape Only an occasional mitotic figure is seen Large areas of degeneration and necrosis are present throughout the tumor

Sections of the liver show metastases These metastases are entirely carcinomatous in character Masses and strands of epithelial cells with some tendency toward alveolar and papillary arrangement are seen The nuclei of these cells vary considerably in size and shape Mitotic figures are fairly numerous There is relatively little connective-tissue stroma

Sections of the lung show similar metastases There is, however, less tendency towards pattern formation and most of the cells are arranged in groups and diffuse sheet-like masses

Diagnosis—Teratoma testis, embryonal type, with carcinomatous areas of entodermal origin and carcinomatous metastases in the liver and lung

From the service of John William Shuman, M D, Hospital, National Soldiers' Home, Sawtelle, Cal

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EXTRAPERITONEAL HERNIA OF THE BLADDER

THIS case is presented because of its diagnostic difficulties, increased surgical risk and unusual findings at operation

E L, colored male, Case No 125,272, Wesley Memorial Hospital, was referred by the cardiac dispensary to the hospital on May 25, 1926, because of a painful mass in the right inguinal region

This mass had been present for about thirty years but had not caused any trouble until several months ago, when the patient was seized with severe pain in the lower abdomen This pain was located over the bladder and over the area of the mass The pain was so severe that he was sent to the Cook County Hospital In six days he got better and went home The pain returned three days before admission and he was referred from the dispensary because of his cardiorenal condition to the local anesthetic clinic

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EXTRAPERITONEAL HERNIA OF THE BLADDER

On admission a large well-developed, well-nourished, colored male was found. In the right inguinal region a soft, resilient, nearly fluctuating mass was found of the size of a goose egg. It was not reducible in size, could not be pushed back into the abdominal cavity, although it seemed to pass into the inguinal canal at the external ring. The palpating finger could not enter the external ring. It did not increase on coughing and pressing. The cord lay on the posterior lateral surface of the tumor. The mass could be separated from the testis.

On the day after admission, Doctor de Takats, with local anaesthesia, exposed the tumor by suitable incision. A resilient fluctuating mass was found here covered by the transverse fascia. The mass was distinctly separated from the cord, which lay posterior and laterally to it. On splitting the transverse fascia a fatty tumor of the size of a fist appeared which was isolated down to the external ring. The pedicle of this mass lay mesially to the epigastric vessels. On dissecting through the fat with two anatomical forceps, a thick muscular layer was found, which was identified as the bladder wall. The wall was hypertrophied and painful on pressure, because sacral nerves were not blocked. The opening through which the bladder prolapsed permitted only one finger-tip to enter. Several attempts to reduce the bladder through this opening were in vain because of the small opening. Therefore a laparotomy was made, starting from the external ring upward. It was now seen, that the prolapsed bladder wall is below the peritoneal reflection. Bladder could now be pushed back in place. There was no evidence of injury to the wall. The lateral vesical ligament was well visible. Peritoneum was closed. A transposition of the cord was made according to Bassini with duplication of the external oblique aponeurosis above the cord. Skin was closed with clips. Uncomplicated recovery.

Discussion—Hernias of the bladder are not rare. Brunner found one in every hundred hernias. They may be inguinal, crural, perineal, obturator, sciatic or even in the linea alba. Most frequently, however, they are direct inguinal hernias, like our case. As to their relationship to the peritoneum, they are intraperitoneal, paraperitoneal or sliding and extraperitoneal. The sliding type is the most frequent. From the analysis of the reported cases it is apparent that most of these sliding hernias are artificial and are produced by the traction on the hernial sack during operation. The extraperitoneal type, to which our case belongs, is very rare. Of a series of 180 cases of bladder hernia, only six of this type were found.

Predisposing factors to bladder hernia can be

(1) *Bladder distention* due to prostatic enlargement, urethral strictures, bladder stone and diverticulum. In our case a polyuria and a pollakisuria were present. A connection between these symptoms and the prolaps of the bladder is hard to establish. The mass, according to the patient's history had been there for thirty years.

(2) *Precvesical lipomata* have been reported in all cases of bladder hernia. Their role just as that of preperitoneal lipomata in hernia formation has often been emphasized and as a predisposing factor generally accepted.

(3) *A weak inguinal canal* which factor involves the whole question of hernia disposition. It seems clear that an overdistended bladder with precvesical lipoma pulling it forward could never pass a normal external inguinal ring.

(4) *Previous injections* at the site of the hernia resulting in scar tissue formation may cause an adherence of the bladder to the inguinal ring (Finsterer's case)

The diagnosis is usually only made at operation and sometimes only when the bladder wall has already been perforated. However, the pre-operative diagnosis is possible if one only thinks of it. Following are the main diagnostic points: a resilient, fluctuating mass, separable from cord and testis, irreducible, painful on pressure, is always suggestive of bladder hernia. If the mass gets smaller after urination, or if a metal catheter can be introduced into the mass through the bladder, the diagnosis is made. These symptoms were not present in our case. The colics are felt over the mass and irradiate to the region of the bladder. A cystoscopic examination will easily reveal the condition.

In our case the colicky pain, which meant bladder incarceration, irradiated over the whole bladder. This symptom has been noted by one of the staff (Doctor Mason). This symptom, together with the other findings, should have aroused at least the suspicion of bladder hernia, which could then have been confirmed by cystoscopy. The diagnosis during the operation is made by the appearance of pievesical fat, below which the typical muscle layer appears. In our case the first attention was drawn to the bladder by the pressure pain, which is unusual in the hernia. Had the diagnosis been made before the operation, a block of the sacral nerves would have easily anesthetized this part of the operation. As it was, it gave a diagnostic lead.

The incarceration of the bladder into the external ring was only partial. The constricting tissues do not seem strong enough to cause a gangrene. In our case, during cystoscopy an œdema of the involved region, with a small submucous hemorrhage was seen. It is impossible to decide whether this was due to the incarceration or the surgical trauma.

Sometimes even the ureteral opening or one of the ureters may be in the prolapse. This may cause a kink and a hydronephrosis. In other instances a diverticulum was found or a stone had formed in the prolapsed part of the bladder. There cannot be a very free communication between the two separated parts of the bladder, as pressure on the mass, like in our case, seldom reduces the size of the prolaps.

Collective statistics with analysis of cases may be found at Imbert (1896) Brunner (1898 and 1909), and more recently Finsterer (1912).

BIBLIOGRAPHY

- Brunner, F. *Über Harnblasenbrüche*. Deutsch. Zeitsch. für Chir., 1898, vol. xci, pp. 121-186.
Idem. *Das Hervorziehen der Harnblase bei Hernienradikaloperationen*. Deutsch. Zeitschr. f. Chir., 1909, vol. ci, pp. 562-580.
 Imbert, P. *Hernies de la vessie*. Annal. de la maladie des organes génito-urinaires, Paris, 1896, vol. xiv, pp. 398-441.
 Finsterer, H. *Über Harnblasenbrüche*. Beitr. z. klin. Chir., 1912, vol. lxxvi, pp. 240-265.
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SURGERY OF COMMON DUCT OBSTRUCTION

SURGERY OF COMMON DUCT OBSTRUCTION

Cholecystectomy is the logical treatment for chronic cholecystitis, with or without stones. The gall-bladder is the birthplace for the large majority of gall-stones, and when infected carries the infection in its walls, so that its removal destroys the infection as well as reducing the chances for recurring stones to a minimum. Removal of the gall-bladder in uncomplicated biliary disease is fraught with very little danger to life, less than two per cent, and from a practical viewpoint causes no inconvenience to the patient.

Common bile duct obstructions are due to stones, post-biliary operations, malignancies, pancreatitis and peptic ulcers, in the order named. Stones by far predominate. It is logical to assume, therefore, that early removal of the gall-bladder in biliary disease will act in a large part in the prevention of duct obstruction.

Stone formation in the hepatic ducts is the exception, and whether or not stones can form in the biliary ducts is at present unknown. As far as is known, stone formation is dependent upon gall-bladder infection and an increase in the cholesterol content of the blood.

While surgery, of course, is the only method of dealing with common duct obstruction, surgery still carries an almost prohibitive mortality. G. P. Malley in a series of acute cholecystitis with common duct obstruction cites a mortality of forty per cent. In chronic cholecystitis with common duct obstruction his mortality was 19.2 per cent. It may be safely said that in all hands, the mortality of common duct obstruction to-day varies between fifteen and fifty per cent. Although transfusions, calcium chloride, glucose, reservation of heat, etc., may have reduced the mortality somewhat, still it is far too high for comfort.

The causes of the high mortality may be classified as follows: (a) Impaired liver function (back pressure) (toxæmia), (b) hemorrhage, (c) general peritonitis, (d) complications which may follow any surgical procedures. The last may carry a mortality of one per cent or less. Therefore the first three carry by far the heaviest mortality.

If these three are the main causes of death therefore, it follows that if they can be eliminated, the mortality will be greatly reduced.

We have attempted to accomplish this in our recent work and now have a series of fifteen obstruction cases with one death, whereas formerly our mortality was very high. The death which occurred was in a case which necessitated a duodenostomy and died from general peritonitis.

The routine is as follows: First stage Cholecystostomy. Second stage Removal of duct obstruction. Third stage Cholecystectomy. The first stage consists of exploration and drainage of the gall-bladder, care being taken to remove all stones in gall-bladder and cystic duct so that drainage will not be impaired. The tube for drainage is anchored to the gall-bladder with linen or silk and the wall is carefully invested about the tube to prevent leakage so as to reduce adhesions to a minimum.

The patient is then allowed to rest for several weeks or months if neces-

BRIEF COMMUNICATIONS

say until jaundice has entirely disappeared and until blood-clotting, settling and viscosity are normal. Checking may also be made with the Vonden Bergh test—a very satisfactory test in this type of case.

When all these tests are normal the second operation is performed, removing the obstruction if possible, and always opening and draining the common duct, even in case of duodenostomy. The gall-bladder and its drainage tube from the first operation are not disturbed.

The tube in the common duct is removed in seven days and the tube in the gall-bladder removed several days later.

Whether or not to perform cholecystectomy, the third operation, is dependent upon the condition of the gall-bladder, found upon exploration. In my opinion it is advisable in all such cases to remove the gall-bladder, to prevent possible recurrences.

The above procedures, at first sight, might suggest difficulty in re-operating upon operated ground, but such has not been our experience. The few adhesions found at the second and third operation are readily dispersed to make way for the later procedures.

The procedures are not unlike preliminary cystotomy in advanced prostatic removal (two-stage operations). The advantages are as follows:

First. By preliminary drainage, back pressure on the liver, with return to normal function, is overcome. This in our opinion is the most frequent cause of death in these cases (toxæmia from low liver function).

Second. The danger of hemorrhage is absent by the removal of the bile pigments from the blood (removal of jaundice).

Third. Peritonitis is less apt to occur because of the walling-off process which follows the first operations—because of increased protective agencies of blood and peritoneum due to the removal of toxic substances from the blood—a certain amount of immunity produced (non-specific) following the first procedure.

Although our number of cases have been rather limited (fifteen), still it seems to me in following these cases that a condition which has hitherto carried a high mortality rate may be reduced in severity to one conforming with other surgical procedures, and should carry a mortality not to exceed two per cent.

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A STUDY OF GAS GANGRENE IN CIVIL SURGERY

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THE anaerobic bacillus *aerogenes capsulatus* was isolated and fully described by Welch and Nuttall¹ in 1892, in an autopsy study of general emphysema. Frankel also described the bacillus independently in 1893, and by experimental as well as clinical studies, established it as the cause of gas gangrene. Ever since, medical literature has contained a constantly increasing number of reports concerning the lesions produced by this organism. By 1900, Welch had collected forty-six cases, in thirty of which the infection was mixed, fourteen showed pure culture of the bacillus, while in two cases no clear statement is made of the bacteriology. It is interesting to note the scope and trend of those forty-six cases. Eighteen were complications of compound fractures, seven were subsequent to gunshot wounds, and three followed hypodermic needle injections. Two cases developed after external urethrotomy, while single cases complicated removal of the appendix, operation for strangulated Littre hernia, nephrectomy, prostatic abscess, self-catheterization, and incision of submaxillary abscess. Five cases, non-traumatic in character, are listed, one after erysipelas, two cases of seeming spontaneous gangrene—questionably diabetic, primarily, and two cases without explanation. These cases in which the predisposing conditions were obscure were termed idiopathic by Greely,² who made an extensive study of such non-traumatic forms in 1916. He showed how exceedingly widespread the bacillus *perfringens* is. Achalmé found it in the blood of persons suffering from rheumatism and in the myocardium of two individuals who had died of "acute articular rheumatism." Vallen and Zaber in gangrenous suppurations of the appendix, Guyon, Albanian, Jungano in urinary abscesses, Frankel in an inflammatory swelling, while Chaillons and Bendetti found the organism in ocular infections. It is a normal inhabitant of the alimentary canal of man and many of the lower animals with distinct pathogenic abilities, and it possibly plays a part in the etiology of certain forms of diarrhoea. It would be expected that lesions of the abdominal organs, due to various pathological conditions, such as tumor, obstruction, ulceration and inevitable traumatism of abdominal surgery, would not infrequently be followed by inflammation directly caused by this bacillus. In Greely's study, nine cases

* Read before the Philadelphia Academy of Surgery, November 1, 1926.

of positive blood cultures in the living were summarized. Six proved fatal subsequently, ranging in time from a few hours to three months. Three recoveries are noted, after cholecystitis and appendiceal operations.

In the 175 cases collected from the literature up to 1915, by Simonds,¹ the relative number of several types of wounds was as follows: Compound fracture, 61, lacerated wounds, 20, operation wounds, 11, gunshot wounds, 10, and hypodermic needle punctures, 9. Thus nearly as many cases of gas gangrene developed in hypodermic needle punctures and slightly more in operation wounds than in gunshot wounds. Gas gangrene was twice as frequent in lacerated wounds, six times more frequent in compound fracture cases than gunshot wounds. This refutes impression gained from war reports that gas gangrene was peculiarly incidental to gunshot wounds.

In the experiments of Bullock and Cramer,⁴ particles of wood, cloth, paper and other foreign substances after being soaked in a suspension of B. Welchii were introduced beneath the skin of mice with negative results. The presence of certain calcium salts aid in the production of gas gangrene. Doses of two and one-half mgm of calcium chloride injected with a suspension of B. Welchii or of Vibrien septique never failed to produce gas gangrene in experimental animals. Calcium nitrate and calcium acetate have the same effect. Their conclusions were that the calcium salts produce at the site of injection a local change in the tissues, which lessens their defensive mechanism. Therefore we may conclude that the increased devitalization which includes both bone and soft tissue is probably an important accessory cause for the increased susceptibility of compound fracture over other wounds for the development of gas gangrene.

A clinical paper of great importance was contributed by Cramp⁵ in 1912. His observations and deductions from an extended series of cases in matters of surgical principles, treatment and prophylaxis are worthy of reiteration. For the total 187 cases collected by him, the gross mortality was 48 per cent. There were in all 50 amputations with 18 deaths and 32 recoveries, a mortality of 36 per cent from this form of treatment. In contrast to this mortality of 36 per cent for amputation, there were 30 cases involving the extremities, treated conservatively by free and generous incisions followed by continuous or frequent irrigations in baths, with three deaths. All three were due to complications, one from tetanus, one from secondary hemorrhage and one from mixed infection twenty days after injury. In each case the gas infection was fully under control some days before death occurred, nor could this author find a single instance where generous and free incisions were made at the outset, after which the wound was continuously irrigated or placed in a bath, that death had taken place. Three of these thirty cases were amputated at some period in their convalescence on account of destructive effects of the disease, but not to control it. There were nine other cases also treated in this conservative manner, where the infection was located upon the trunk, all but one were superficial and all but this one, which was a deep infection in the gluteal region, recovered. He was again unable to find a

single instance of death where the infection had been limited to the tissue, external to the deep fascia which seems extremely resistant, no matter what form of treatment was emphasized. He observed a series where amputation had taken place below the limits of infection, through diseased tissues or the stump reinfected and recovery in every one resulted where the wound was opened widely, incisions made and irrigation instituted, except in one instance complicated by tetanus.

Prophylaxis is probably the most important aspect of treatment. All wounds in which great force had been exerted, and especially those contaminated by soil or dirt-covered objects, should be treated as if infected with gas bacilli. They should be left open whenever possible and given continuous irrigation. The wounds should always be so dressed that frequent inspection can readily be made. Encasements of plaster should never be made in such suspected wounds. He noted in the majority of the cases that pain out of all proportions to the trauma came on twelve to thirty hours after injury and was the first sign of trouble. This was followed by a sudden rise of temperature with marked rise in rate and weakness in pulse. Pus was seldom seen early. It appeared also that those cases described as mild were either in the incipient stage where the case is discovered early, or those cases superficial to the deep fascia. Finally gas infection once well established showed rapid progress with destruction, and appeared certain to result in death, without treatment. Such was the conception of gas gangrene infection before the outbreak of the World War considered as a mono-specific invasion usually caused by *B. Welchii*. However, workers who have since made bacteriologic studies of their material, emphasized that gangrenous invasions, following war wounds, were usually polyspecific. The findings in the cases of Weinberg and Segun⁶ are the most carefully worked out and discussed. These authors described more numerous and more highly polyspecific infections than did other workers. This must in all probability be attributed to their technic. They used for isolation deep glucose agar shakes wherein the flora is spread out like a map and wherein relatively accurate estimates of the different organisms may be made. In Weinberg's⁶ experience *B. Welchii* or *B. perfringens* was found in nearly two-thirds of the cases of gas gangrene. These researches agree with those made previous to the war and resumed by Simonds. There was another combination of microbes which was found in the so-called classical form of gas gangrene, which is the form usually described in surgical literature, with definite constitutional and local signs. The bacillus of malignant oedema is the chief pathogenic organism in this group. Sometimes in the flora of the classic form of gas gangrene a new species was found, which Weinberg and Segun described under the name *Bacillus oedematiens*. Its typical characteristic is the formation of a toxin which, if injected into a guinea pig, produces a special white oedema. These authors made experimental production of gas gangrene with these three main organisms. It was easier to reproduce experimentally, in animals, the toxic forms of gas gangrene with *Bacillus oedematiens*.

In the experimental toxic gas gangrene, the muscles are red and hyperæmic. The gas infiltration is more or less completely masked by a toxic œdema, which develops progressively up to the trunk. These workers are able to reproduce a mixed form of gas gangrene by injecting the experimental animals with a mixture of *B. perfringens* and *Bacillus œdematiens*. Also it was easy to reproduce a putrid strain of any given form of gas gangrene by introduction of *Bacillus sporogenes*. These French workers in bringing forward their proof for the polyspecific causes, clearly defined gas gangrene by the local and general symptoms known in general surgical literature. The local symptoms are essentially gaseous infiltration with gangrenous deterioration of the tissues, especially muscular and with a characteristically foul odor. Importance of these symptoms varies from case to case, hence the manifold clinical types. The general symptoms are constant and are marked by extensive intoxication, characterized especially by increased rapidity and extreme weakness of pulse, dyspnoea, without thoracic lesion and earthy, sometimes icteric, color of the skin. These serious forms were carefully differentiated from a large number of gaseous infections, far less serious, not accompanied by the general phenomena described above and amenable to purely surgical intervention. These organisms were all capable of reproducing the double series of symptoms, local manifestations and general intoxication. Sacquepee found that the *B. perfringens* can reproduce the local lesions of gas gangrene, but it cannot be made to produce a potent toxin. He found the other organisms produced very active toxins and, experimentally, they produced lesions closely analogous to those observed in cases of gas gangrene in man. While *Bacillus perfringens* is found in 82 per cent of his cases, he seems to minimize it in his writing and feels that it is the least noxious of the etiological factors.

Bacillus aerogenes is an organism of but limited virulence, however, in so far as this term indicates its ability to proliferate in the living normal tissues. In order that infection by this bacillus may become established, it is necessary that the tissues in which the microorganism is implanted be devitalized. However, in the body, *Bacillus Welchii*, once it has obtained a foothold in muscle tissue, is able to spread with extreme rapidity in consequence of its ability to destroy and devitalize contiguous muscle tissue. The organism grows well only in muscle and in the liver. Its ability to produce gas and tissue poison depends upon the presence of glycogen in the infected tissue. Wright¹ conducted extensive experiments by which he showed that *B. Welchii* would grow most prolifically in bouillon to which potato had been added. He used platinum rust and other mechanical factors to provide something to serve as a cranny in which the microbe can get a start by concentrating its chemical effort at first upon some nidus of the medium. Wright commented upon the difficulty met with in starting the growth of cultures of the *Bacillus Welchii* in serum and the avalanche-like progress made when once such a start had been effected, and compared this to the way in which wound infections with this organism often become rapidly progressive. Bull and Pritchett² demon-

strated that the toxic products of the growth of *B. Welchii* exhibit antitoxic activities and readily give rise to the formation of active antitoxin substances. They next found that the immune serum developed possessed protective and curative properties. Their investigations in this direction indicate that the development of spores into vegetative bacilli may be prevented by protective inoculation of an antitoxic serum and also that the vegetative bacilli may be deprived of their toxic products, which appear to be the real offensive instrument. Further researches showed that the antitoxin for *B. Welchii* can be prepared from a single strain of the organism which yields under the conditions described a high titer of toxin and this antitoxin can be employed to combat infection or prevent infection by any strain whatever of the bacillus. The preferred habitat of the anaerobic invaders is of interest. The notable muscle feeders are *B. Welchii* and *B. Chauvæi*. They may proliferate metastatically, the latter more than the former. Organisms of the *Vibrio septique* group may feed on muscle and they frequently do, but they show a preference for connective tissue and for serous lining. Moreover they show a remarkable facility for spreading along lymph and blood channels and their invasions are not to be controlled by incision of individual muscles as are *B. Welchii* infections. Many of the organisms of the oedematous group fail to spread rapidly from the site of entrance and act by means of the toxins that advance far before them. Some strains of *B. Novyi* may kill guinea pigs without any invasion at all, while other types such as the bacillus of Ghon and Mucha and the oedematiens strain of Joly, possess very active invasive powers. This question of virulence is a highly relative one. It is probably true that the Welch bacillus has not the toxicity of some other forms. The question of the incidence of gas infection in civil life is of interest. Von Hibler lists fifteen strains of *B. Welchii* that he isolated from human material. Of these only two could be called the direct cause of the death of the patient. Both of them were infections after injury. He lists four strains of *Vibrio septique* type isolated by himself and in three of these cases the organism was demonstrated to be the probable cause of death. He found *Novy's* bacillus once in a human case and it was probably the cause of death. Acquaintance with these three essential species—*Vibrio Septique*, *B. Oedematiens* and *Bacillus Perfringens*—made it possible to consider the specific serotherapy successfully. The first attempts at serotherapy were not very successful since they really aimed exclusively at the species mentioned at the beginning of the War, *B. perfringens* and *V. septique*, taking no account of a third agent of capital importance, the oedematiens. It is only by applying a specific therapy, either against all three germs or against the germ involved in each particular case that a practical result can be reached. The preparation of the serums followed the general principles already established in bacteriology. For toxic germs it is important to prepare the animals for inoculation of the toxic products (so far indeed the antitoxin serums have proved more efficacious, such as antitetanus and antidiphtheria). Weinberg cites an experience of 191 cases treated with gas gangrene serums with 25

deaths, a proportion of 13.09 per cent. For the sake of comparison it must be remembered that in the same regions the mortality in non-treated cases was about 75 per cent. It often operated in a really striking manner for a whole number of cases in which no surgical operation was desirable. From the preventive point of view, serotherapy naturally proved itself still more powerful. Preventative treatment was applied solely in the cases of very severely wounded patients, particularly exposed to gangrene (arterial wounds, extensive shattering of the buttocks, thighs, etc.). A series of wounds of like nature, but not treated with sera, gave 7.2 per cent of cases of gangrene, while only four cases of gangrene in 319 cases treated preventatively were observed. Kenneth Taylor⁹ also emphasized the relative weak toxicity of the *Bacillus Welchii*. He took a highly mechanistic view of the pathological process of gas gangrene. He defined it as the death of an extensive mass of muscle, due to the mechanical pressure action of gas produced from a local focus, by saprophytic bacteria. The substances from which the gas is formed are chiefly carbohydrate-containing tissue. Hence muscle is the tissue primarily involved. He felt that the organism is with rare exceptions the *bacillus aerogenes capsulatus*. He thought that the real action of the toxic principle is that of converting healthy muscle tissue adjacent to the wound into a favorable medium for growth and gas production by the bacteria. The activity of the gas bacteria is limited almost invariably to muscle, and the invasion of the subcutaneous tissue, by bacteria, is rare in man. When it occurs it is usually in the region of the scalp or scrotum, where the skin is comparatively rich in muscle tissue. Sustained pressure within a muscle mass depends on retention by intact muscle sheaths of the gas produced and by the occlusion of the avenues of escape due to the local swelling of the muscle fibres in response to the inflammatory reaction.

The disease then is essentially an infection of muscles and the connective tissue may be at first, at any rate, comparatively little affected. Moreover the spread is longitudinal rather than transverse and the infection spreads from end to end of a muscle, but may be unable to spread from one muscle to another. The affected muscle is at first dull and opaque, brick red in color and resembles cooked meat. Even at this stage it is dead, for it does not contract when pinched and does not bleed when incised. Bubbles of gas which can be pressed up and down between the fibres may be evident to the naked eye. Soon it becomes softer and diffuent, the color changing to green, brown or black. The exudate is blood-stained. Gas can be felt in the tissues over an area considerably greater in extent than those of the dead tissue. The microscopic appearance of the growing edge, as described by McNee and Dunn,¹⁰ throws a flood of light upon the spread of the disease. The first change observed is a separation of the muscle fibre from the surrounding interstitial tissue, with a clear space between fibres which McNee and Dunn considered to be filled with a toxic fluid. The fibre itself loses its shadow and stains a uniform eosin tint. At a later stage the sarcolemma disappears and finally the entire muscle fibre disintegrates and becomes gelatinous. The

bacteria of the spreading edge are confined to the interstitial tissue and do not invade the muscle fibres at first, but at a later stage the disintegrating fibres are crowded with bacteria. It would appear therefore that the bacilli spread up and down the muscle in the interstitial tissue, preceded perhaps, by a toxic fluid which separates the muscle fibres from the interstitial tissues and kills the fibres so that they may be invaded by the bacteria. It is thus easy to understand why the spread should be longitudinal and why it should be seldom in a transverse direction. Blake, in a recent article, gives Taylor credit for improvement in treatment by the suggestions offered in his theory. For, following his teaching, the deep fascia was opened for some distance beyond the original wound. Results were improved thereby, but still better results were obtained by excision of the affected muscles throughout their entire length. It has always seemed to Blake¹¹ remarkable that the sheath of a muscle could confine the infection as it seems to, but he has demonstrated this fact and has dissected a muscle entirely, it being brick red throughout, while adjacent muscles were normal. In his study of antiseptic solutions, he found none that acted so effectively on gas gangrene, as to make its use preferable to others, with the exception of quinine, which in experimental gas gangrene showed strong inhibitory action. His impression is that Dakin's solution owes its efficiency largely to its solvent action upon the pabulum of the bacteria, but in the case of gangrene the dead tissue is so massive as to be beyond the reach of solvents. He also makes a strong plea for the sera in use at the end of the war and now, which are our chief reliance in treatment and aid in combating this terrible infection. He also cites cases where the entire process was arrested by the use of sera even without operative intervention, in cases which from their extent and character would have proven fatal without serum therapy.

Cases of anaerobic invasion exclusive of tetanus, coming to necropsy in civil life, may be classified into two groups, one group is that of patients being weakened by sickness or operation, and invaded by their own intestinal bacteria. Such invasions, though they may be and frequently are polyspecific, usually have for their chief invader the Welch bacillus. But systemic or local invasions (the second group) following wound invasions, under which head comes puerperal infections, especially such invasions as have small foci, are frequently not caused by *Bacillus Welchii*, even though the latter organism may be found. The severity of tissue destruction and the presence of foreign matter has much to do with the type of invader capable of multiplying in the first few hours. Finally the resisting powers of the patient must be weighed. Binne¹² cites the rather extensive sclerotic changes noted in the liver and kidneys of many young soldiers who were apparently in perfect health. Such latent pathological conditions may well lower the resistance of their subjects and may explain to some extent why of two similar individuals who have suffered similar wounds, have been similarly exposed to infection, and have been identically treated one succumbs to the infection and the other overcomes it.

In 1922, Christopher,¹³ after a rather careful search in recent literature of gas gangrene, was able to report only nine cases by seven authors. All were traumatic, including one case complicating a septic criminal abortion. This report covers the time from Simond's résumé in 1915 to 1922. Despite the paucity of reported cases Christopher was inclined to the belief that gas gangrene is encountered rather frequently in civil surgery, but not reported. From 1922, the time of Christopher's paper to date, we have collected twenty-six authors writing clinical papers upon this subject, reporting 64 additional cases. Twenty-six are clearly of traumatic origin, twenty complicate obstetrical and gynæcological states where the cause may be traumatic or non-traumatic, for the authors differ in their disposition of these cases. The remaining eighteen cases include those cases in which the process is caused by the subject's own intestinal organisms. This series includes eleven cases complicating gangrenous appendicitis and its sequelæ. Jennings¹⁴ finds that the evidences of intoxication due to the B. Welchii in the peritoneal cavity are insidious in their onset and do not differ from those which have been associated with septic peritonitis for many years. There may or may not be a rise in temperature. The pulse frequently rises, cyanosis in some degree is an early sign and increased with the severity of the case. As the case advances the pupils dilate, the skin becomes cold and clammy, while the pulse becomes thready and feeble and impalpable. Consciousness is frequently unimpaired until the last or a short period of delirium may occur. The cyanosis now becomes extreme and death supervenes. This author reports brilliant results with the tetanus-perfringens serum of Bull and Pritchett. Two cases each were associated with ruptured gastric ulcers, cholecystitis and ischio-rectal abscesses. One case complicated liver abscess.

CASE REPORTS

During this period since Christopher's report in 1922, we have found six clinical cases in the records of the Methodist Episcopal Hospital of this city and we believe other hospitals can show similar reports. We wish to report two personal cases, traumatic in character, in which we were able to follow the processes from their onset. Gas gangrene serum was used early and energetically in both cases—the wounds were treated later largely by physio-therapy while necessary auxiliary surgical procedures were employed to make cures complete. The remaining four cases have occurred upon the services of our colleagues who have kindly allowed us to put their cases in this record.

CASE I—October 7, 1923. J. D. P., a small, poorly nourished Italian boy, aged ten, was shot with a shot gun at very close range while playing in and about the collected refuse known in the southern part of the city as the "dumps." After he fell in a dirt road by these refuse heaps he was picked up by several boys. The police were called and brought him to the accident ward of the Methodist Hospital, where emergency measures were taken for large bleeding wounds upon the anterior, inner aspect of the right and left upper thighs. Much dirt, burned portions of clothing and gun wadding were present in the wounds. These wounds were large and irregular in outline. Much skin, deep fascia and muscle were destroyed and the released muscle

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tissues bulged out of the jagged and torn wounds. The wounds were dressed, after preliminary cleansing and debridement, with dichloramine and sterile dressings. 1500 units of tetanus antitoxin were administered. He was admitted to the service of Dr. J. H. Baldwin.

Physical examination revealed a small, poorly nourished Italian boy, quite lacking in general hygiene, with carious teeth, injected pharynx and cryptic tonsils, but with no adenopathy. Chest was flat, lungs were normal, while the heart showed a soft, systolic murmur with accentuated second pulmonic sound. The abdomen was negative. The upper thighs showed the wounds noted upon admission, but bleeding was checked. There was no odor in the wounds.

Severe pain, feeling of apprehension and marked mental alertness were noted. October 8, 1923, at 3 A.M., the temperature per rectum was 105° F and the dressings were bloody. Upon removing those of the right thigh a few small bubbles were noticed issuing from beneath the disrupted sartorius muscle. The tissues (muscle) were markedly swollen, parchment-like and in part of gelatinous consistency. The pulse at the internal malleolus and the popliteal space was present.



FIG. 2.—Gunshot wounds followed by gas gangrene.

Welch Bacilli were found in smears and later in pure culture in inoculated rabbit's blood. At 10:30 A.M. there was marked pain, rising temperature, rapid pulse of weak volume, and a severe generalized convulsion, lasting ten minutes. There was marked restlessness, apprehension and some degree of delirium. Discoloration through torn tissues and in the intact skin was becoming more progressive. At 12:15 P.M., 50 cc of commercial gas bacillus serum was given intramuscularly in the back. The peculiar characteristic odor was first noted, while many bubbles were seen to issue from beneath and around the torn and swollen muscle. Moderate quantities of very thin seropus accompanied the gas. Evidence of fascial necrosis was already present. At 4 P.M., within the first twenty-four hours after the injury, a second 50 cc tube of the gas gangrene serum was injected intramuscularly. These injections were repeated in similar

manner upon the next two successive days. The extent of the process locally and the general toxæmia were seemingly checked by the first doses. After the fourth injection the patient was brighter, freer of pain and was anxious and able to take nourishment. During these days and subsequently, the left thigh wound was carefully protected and redressed lightly while the extremities and trunk were under an electric light cabinet continuously. We ordered irrigations of hydrogen peroxide every second hour. With a soft catheter, connected to a compressed gas tank, oxygen was bubbled through the depths of the wound at frequent intervals. This therapy while persisted in regularly, did not seem to change the conditions of local necrosis in any degree, and we are unable to say whether it was of any value. Four additional doses (50 c.c. each) of the gas gangrene serum were administered intramuscularly during the next seven days. Secondary invaders, hæmolytic streptococci and staphylococcus aureus were noted in the wound secretions. No *B. Welchii* were found in any subsequent bacterial studies. November 5, 1923. X-ray report showed in right thigh, a large charge of small bird-shot (middle of inner thigh). Left thigh showed only six small bird-shot.

November 28, 1923.—Under gas anæsthesia, the various sinuses in the posterior right thigh were opened and many pockets of small shot were removed. The wounds were flushed daily and physiotherapy, which had been started earlier, continued. The patient was discharged without contractures, but with one small, granulating wound. Further treatment was continued in the out-patient department and the sinus soon closed.

March 11, 1926.—The X-ray revealed six shots still in the left thigh, while many shot were scattered through the area of the old infected site in the right thigh. Patient has no contractures. General condition and hygiene improved.

CASE II—June 19, 1925. J. F., aged ten, was brought to the Methodist Hospital giving a history of falling and injuring his right forearm while jumping from a coal car to an oil tank along the railroad right of way in South Philadelphia. Upon examination in the accident ward a compound fracture of the ulna was noted, with marked laceration along the ulnar aspect in the area of the upper and middle third of the forearm. There was much dirt ground into this deep wound, but the fragments were not protruding. The wound was cleansed, debrided, dressed with iodine and sterile gauze. Antitetanic serum was given, X-ray taken, and then the patient was permitted to go home.

The X-ray showed fracture of the ulna in the middle of the right forearm in rather poor position. There was some rotation with slight overlapping. The following day he was admitted to the hospital as the lacerated area was swollen and very painful. Free and generous incisions were made after culture of the wound secretion. *B. Welchii* was reported as positive in pure culture from inoculated rabbit. The arm was placed under an electric light cabinet and given baths in hot solutions of magnesium sulphate at regular intervals. Fifty c.c. of gas bacillus serum were given intravenously. This dosage was repeated daily, intravenously, for three days. Applications of 2 per cent mercurochrome, baths of hot magnesium sulphate solution with the injured extremity—exposed to electric light under a cabinet were continued. The local and general signs were quickly controlled and held under control. Hæmolytic staphylococci and streptococci were found in wound secretions, subsequently.

July 11, 1925.—X-ray report shows the upper fragment of ulna resting on radius. Cultures from this date were negative for *B. Welchii*. Patient was discharged from the hospital July 22, 1925, with sinus formation and treated in the out-patient department and X-rayed at frequent intervals. A sequestrum formed, and on March 7, 1926, he was readmitted to the hospital and operated on under ether anæsthesia. Incision was made about the sinus in which a probe had been placed. The incision was freely extended and deepened to the fusiform new bone growth. The upper wall of the involucrum was removed with a chisel and the old sequestrum was easily extracted. The wound was dressed with 5 per cent mercurochrome and light gauze packing and redressed in the ward. Convalescence was uneventful. Function was excellent.

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CASE III—R. T, age fifty-eight Male Admitted to the service of Dr George Ross, August 12, 1922, with severe pain and marked swelling in right groin, which developed while working as a laborer, one day previously Swelling soon appeared after the inguinal pain, which swelling became larger, more painful and intense He had never worn a truss and never suffered a rupture before He was rushed to the hospital and an emergency operation was performed by Dr Calvin Smyth Two days later, August 14, 1922, swelling and induration were noted in the operated area, with a dusky change in the color of the skin Progressive induration was noted, extending very rapidly up the sides of the trunk and down the thighs The clinical diagnosis of gas gangrene was made after the wound was reopened Culture showed the bacillus of Welch Patient died two days after the radical reopening, which included orchidectomy (right) Hydrogen peroxide locally and all forms of stimulation were administered

CASE IV—W H G, age forty-one, male Admitted to Dr D E Despard's service February 3, 1923, with a crushing laceration of the left forearm when the patient was caught in the gears of machinery in a rope factory A debridement was performed and the ulnar artery was tied There was no fracture and there was no tendon involvement The radial artery showed injury It was macerated and filled with clot for some distance February 5, 1923, infective processes were noted in the lower forearm The culture report of February 6, 1923, showed the presence of gas bacilli Radical incision and drainage of the left forearm was done February 6, 1923 The Carrel-Dakin treatment was instituted February 7, 1923, the process was progressive and amputation of the arm was performed three inches above the elbow Patient became very toxic, pulse very high and temperature progressively higher through February 8, 1923 Death February 9, 1923

CASE V—H B, age thirty-eight, male Admitted to service of Dr D L Despard, July 6, 1923, with a deep laceration of the left forearm The radius and ulna were fractured All arteries except the interosseal and all the nerves were severed Debridement and sterilization of the wound were carried out, radical drainage was instituted while tetanus anti-toxin was given upon admission July 8, 1923, a peculiar odor was noted about the dressings Induration and crepitation were present with a parchment-like appearance in the exposed muscle Gas was found issuing in the wound in the forearm Amputation was performed in the upper arm Recovery was uneventful

CASE VI—R L, age fifty-four, male April 18, 1925, was admitted to the service of Dr L J Hammond with a laceration of the right leg below the knee, in which the skin was so ground with cinders and dirt, that it was hardly recognizable The gastrocnemius and soleus were partly torn from their origin and severely mutilated There was a fine gritty material uniformly scattered throughout the tissues A debridement was done April 19, 1925, at 2 P M while the patient's general condition appeared satisfactory, there was no pulsation felt in the foot At 6 P M this day, crepitation was noted at the right knee At 10 P M crepitation and induration had progressed beyond the inguinal ligament Radical multiple incisions were made throughout the thigh and abdomen Gauze strips, soaked in neutral 1 per cent acriflavine, were laid loosely in the wound, 100 c c of gas bacillus serum were given, intravenously Patient died, April 20, 1925, at 3 A M

CONCLUSIONS

Christopher's remarks in 1922 surely have brought considerable increase in the number of cases reported from civil surgery All authors using anti-toxic sera give urgent advice to use these aids prophylactically and curatively

BIBLIOGRAPHY

- ¹ Welch and Nuttal Bull Johns Hop Hosp, 1892, vol 1, p 410
- ² Grady W Idiopathic Gas Gangrene Bull Johns Hop Hosp, 1916 vol XXVI, p 216
- ³ Simonds, J S Welch Bacillus Rockefeller Monograph, No 5 1915

- ⁴ Barney and Heller Detailed Bacteriologic Study of a Case of Gas Gangrene Arch Surg, 1922, vol iv, p 470
- ⁵ Pilcher, J Considerations of Gas Bacillus Infections with Special Reference to Treatment ANNALS OF SURGERY, 1925, vol lxxx1, p 198
- ⁶ Weinberg, M Bacteriological and Experimental Researches on Gas Gangrene Proc Royal Soc Med, London, 1916, vol ix
- ⁷ Wright, A Conditions which Govern the Growth of the Bacillus of Gas Gangrene in Artificial Culture Media Royal Soc Med, 1916, vol ix
- ⁸ Bull and Pritchett Toxin and Antitoxin of and Protective Inoculation Against Bacillus Welch Jour of Exper Med, July, 1917
- ⁹ Taylor, K Gas Gangrene, Its Causes and Treatment Bull Johns Hop Hosp, 1916, vol xxvii, p 308
- ¹⁰ McNee and Dunn The Method of Spread of Gas Gangrene into Living Muscle Brit Med Jour, 1917, vol ccv, p 610
- ¹¹ Blake, J War Recollections, Military Surgeon, 1926, vol 1, p 25
- ¹² Binnie, J F Keen's Surg, vol viii
- ¹³ Christopher, F Gas Gangrene in Civil Surgery Int Clinics, 1922, vol 1, p 129
- ¹⁴ Jennings, J E Rôle of Welch Bacillus in Gangrenous Appendicitis and Use of Antitoxin of Bull and Pritchett on its Treatment New York M J, 1923, p 682

OBSERVATIONS ON THE SURGERY OF THE LARGE ARTERIES*

WITH REPORT OF CASE OF LIGATION OF THE INNOMINATE ARTERY
FOR VARICOSE ANEURISM OF THE SUBCLAVIAN VESSELS

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AGES ago Celsus, Galen, and Paulus Aeginata began a discussion on the ligation of large arteries which has continued unabated down the many centuries. That the question had not been settled has been demonstrated in recent years by improvements introduced from the proving ground of military surgery,¹ and additional evidence from the experimental laboratory is now available, in support of a new procedure that may be applied in this comparatively simple operation. To illustrate some of the principles underlying the surgery of the large vessels, certain experiences from the operating room and laboratory are presented.

Ligation of the Innominate Artery—That ligation of the innominate artery is a dangerous surgical procedure is apparent from a mortality of approximately 66 per cent in the recorded cases. As the circumstances that demand it occur but rarely, the following case report may prove of interest.

W M P, a coal miner, twenty-five years of age, sustained October 22, 1922, a pistol shot wound in the right clavicular region. A profuse hemorrhage occurred but this was easily controlled, after an excessive loss of blood, by slight pressure. Several days after the accident, the patient discovered a filbert-sized tumor presenting just above the middle of the right clavicle, about 2 cm above the small healing wound of entrance. At the time of discovery, he noticed in it a continuous buzzing, like that of a bee, which seemed to be more pronounced with each beat of the heart. There was a slow but gradual increase in the size of the swelling during his five weeks' stay in bed, and a much more rapid increase in the few days that elapsed following his discharge from the hospital. There was no paralysis at any time. Following the accident the patient noted a vigorous beating of the heart even when lying flat in bed, and a very rapid pulsation with the slightest effort.

Examination—On his admission to the Johns Hopkins Hospital on November 29, 1922, a large tense pulsating swelling occupied the supraclavicular fossa on the right extending from the midline in front to the anterior border of the trapezius in back (Fig 1). The point of entrance of the bullet was marked by a small scar located just above the midpoint of the clavicle. There was no wound of exit, and a roentgenogram revealed the bullet in the region of the left apex. A continuous thrill was palpable, more pronounced in systole. On auscultation a loud, continuous "machinery-like" murmur was heard also more pronounced in systole. Deep pressure applied immediately above the centre of the clavicle caused both the thrill and the bruit to disappear entirely. With their disappearance the patient noticed, subjectively, a temporary slowing of the pulse. Release of the pressure was followed momentarily by a feeling of rapid beating of the heart. Deep pressure sufficient to obliterate the thrill and bruit also caused very definite though transitory alterations in the general blood-pressure. Before compression, the

* Read before the Idaho State Medical Association September 4, 1926.

pressure in the left arm was 108 systolic and 62 diastolic. On deep compression above the centre of the clavicle the systolic pressure rose momentarily to 112 to 114, dropping immediately to 108. On releasing this compression, the pressure fell to 102, recovering almost immediately to 108. Variations in the diastolic pressure on compression of the artery were not demonstrable, but on releasing the compression, the diastolic pressure fell to 48, recovering within a few seconds to 62. Before operation, the systolic blood pressure in the right arm was consistently 4 to 8 mm Hg lower than in the left arm. The superficial veins of the forearm were more prominent on the right than on the left.



FIGS 1 and 2 —Photographs before operation. The circle indicates point of entrance of bullet. Note the evident enophthalmos.

There were no disturbances of motion or sensation in the right arm. The relative cardiac dullness measured 3 cm x 8.5 cm and a teleorontigenogram showed no cardiac enlargement.

In view of the continuous thrill and bruit, and the definite though slight variations in blood pressure and pulse on compression of the swelling,² a diagnosis of varicose aneurism of the subclavian vessels was made. The communication between the artery and vein was probably a small one,³ but associated with large false aneurismal sacs arising from the wounds in the vessels.

The operation was planned to expose the subclavian artery and vein by resection of the clavicle and, either to close the wounds in the vessels, or to perform a quadruple ligation proximal and distal to the abnormal communication. Having in mind the possible necessity of placing a temporary ligature on the innominate and carotid arteries, the exposure of these vessels was first practiced in the anatomical laboratory.

Operation—A horizontal incision was made along the line of the clavicle to the sternum, which bisected a median vertical incision at right angles to it. The medial two thirds of the clavicle was resected subperiosteally. At the junction of its middle and inner thirds, the clavicle showed some erosion, and the periosteum posteriorly was missing over an area about 1.5 cm in diameter. The black, blood-stained appearance

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of the tissues in this area made us apprehensive lest the clavicle formed a part of the wall of the aneurism. This fear had just been expressed, when the aneurism burst at this point with the escape of a large gush of *arterial* and *venous* blood under great pressure. Fortunately, the tide was effectively and immediately stemmed by the operator's thumb placed in the defect in the periosteum. The force of the pulsation and the size of the stream which had suddenly engulfed the field was sufficient to preclude any possibility of removing the thumb even for an instant without exsanguinating the patient. Dr William F Rienhoff, my able assistant, proceeded with the resection of the clavicle and sternum, and Dr Robert T Miller, Jr, very kindly stepped in to expose the innominate artery and to place around it a tape ligature for its temporary control. Included in the ligature was a small length of rubber tubing which enabled us to occlude the artery without crushing its walls, and which would permit us to remove the tape without damage to the vessel if so desired. The common carotid was exposed and occluded in similar manner. Following the occlusion of these arteries the pulsation of the swelling ceased, and the diminished pressure in the sac enabled me to release my thumb and to continue the operation from this point. By pressure on the aneurism just above the defect in the periosteum the escape of blood was completely controlled, thus permitting the application of a number of interrupted silk sutures, deeply placed so as to include the periosteum and underlying tissues. A second line of sutures was applied burying the first. These sutures included in all probability the underlying subclavian vein. Following their application, with the temporary ligatures on the innominate and carotid vessels in place, no bleeding from the defect in the sac occurred. The carotid ligature was removed without bleeding from the aneurism. Slight release of the tape encircling the innominate artery permitted pulsation to return in the sac accompanied by some bleeding. Accordingly, a permanent tape ligature, occluding the innominate artery but not crushing it, was applied. The patient's condition, as revealed by a weak and rapid pulse, prevented any further procedures, and the wound was closed in layers *without damage*.

There was some apprehension lest ligation of the artery alone, proximal to an arteriovenous communication, would result in gangrene of the limb, but as previously noted, it seemed highly probable that the subclavian vein was included in our deeply placed sutures. This would account for the complete and permanent cessation of the thrill and bruit which followed the operation.

An interesting observation immediately after the completion of the operation was the very marked pallor and complete absence of perspiration on the right side of the face ending abruptly in the midline of the forehead, nose, and chin. The left side of the face was flushed and perspiring profusely. This difference had completely disappeared by eight o'clock in the evening, six hours after the operation. Immediately after the operation, the right radial artery was collapsed and pulseless. Within eight hours, the radial vessel, though filled with blood, showed no pulsation. Twenty hours later, a feeble pulsation had returned in the right wrist. There were no paralyses or objective sensory variations but there was a subjective numbness of the entire right arm and hand which disappeared within forty-eight hours. Two days after the operation the blood-pressure in the left arm was recorded as 132 systolic and 76 diastolic. Four days after operation the large pulsatile swelling had subsided almost completely and the neck had again assumed a normal contour. There was no pulsation, bruit, or thrill. On two occasions,

thirteen and twenty days after operation, a small opening along the line of incision was made to evacuate old fluid blood. On the day of discharge from the hospital, a good pulse could be felt at the wrist, and the right carotid and temporal vessels felt full and firm. There was no difference in the appearance of the veins of the two arms but venous pressure on the right was slightly increased. The veins of the left arm were completely collapsed when the arm was elevated four degrees above the horizontal, whereas the veins on the right did not collapse until the arm was 20 degrees above the horizontal. This was interpreted as indicating that the subclavian vein had been occluded at the operation. Subjectively the patient felt that his heart was beating less forcibly and less rapidly than before operation. The blood-pressure in the right arm was 76 systolic and 74 diastolic, and in the left arm 120 systolic and 76 diastolic, the general blood-pressure being definitely increased since operation.

One year after operation the patient again appeared for examination. His right arm still seemed weaker than the left, but gradual improvement was taking place. Some interesting observations had been made by the patient. He perspired only on the left side of his face, the right face and right arm felt colder in cold weather than did the left, when hot or excited he felt a throbbing on the left side of his head and not on the right. On examination, a slight enophthalmos was still present, but the pupils were equal (Fig. 2). The neck showed no swelling or abnormal masses. The pulsation in the right carotid and right radial arteries was weak, and followed the pulsation in the left carotid and radial vessels by a definite interval. There was no atrophy nor objective weakness of the arm muscles. The heart was normal. The blood-pressure in the left arm was 118 systolic and 92 diastolic, and in the right arm 90 systolic and 70 diastolic. It seemed probable that a permanent cure of the aneurism had been effected.

In spite of the failure at operation to demonstrate a definite communication between the artery and vein, all the clinical evidence, together with the escape at the operation of both venous and arterial blood from the defect in the aneurismal wall, justified the diagnosis of varicose aneurism of the subclavian vessels. If this diagnosis be accepted, it is difficult to explain the success of this operation on the simple ligation of the innominate artery, and it seems highly probable that the occlusion of the subclavian vein contributed to the effectual elimination of the aneurism. This inference is made because of experimental observations that complete cessation of the thrill and bruit of a fistula follows the ligation of the vein proximal to the abnormal communication.²

Simultaneous Ligation of Artery and Vein—A better understanding of the treatment of this type of abnormal communication between the vessels may be credited to the extensive experience of the eminent English surgeon, Sir George H. Makins.¹ In the South African War, proximal ligation of the artery for arteriovenous communications was followed in over 50 per cent of the cases by gangrene of the limb. This observation, together with similar

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experiences in the early part of the recent war, prompted the recommendation at the Interallied Conference of Surgeons held in Paris in May, 1917, that the ligation of a large artery for injury should be accompanied also by the occlusion of the satellite vein, even though the latter be uninjured. It may be recalled that the writings of eminent surgeons of the past have always stressed the need of preserving carefully the accompanying vein. Aneurism needles were applied so as to avoid injury to the vein. Operations were devised with the primary intent of preserving the vein. It is evident,

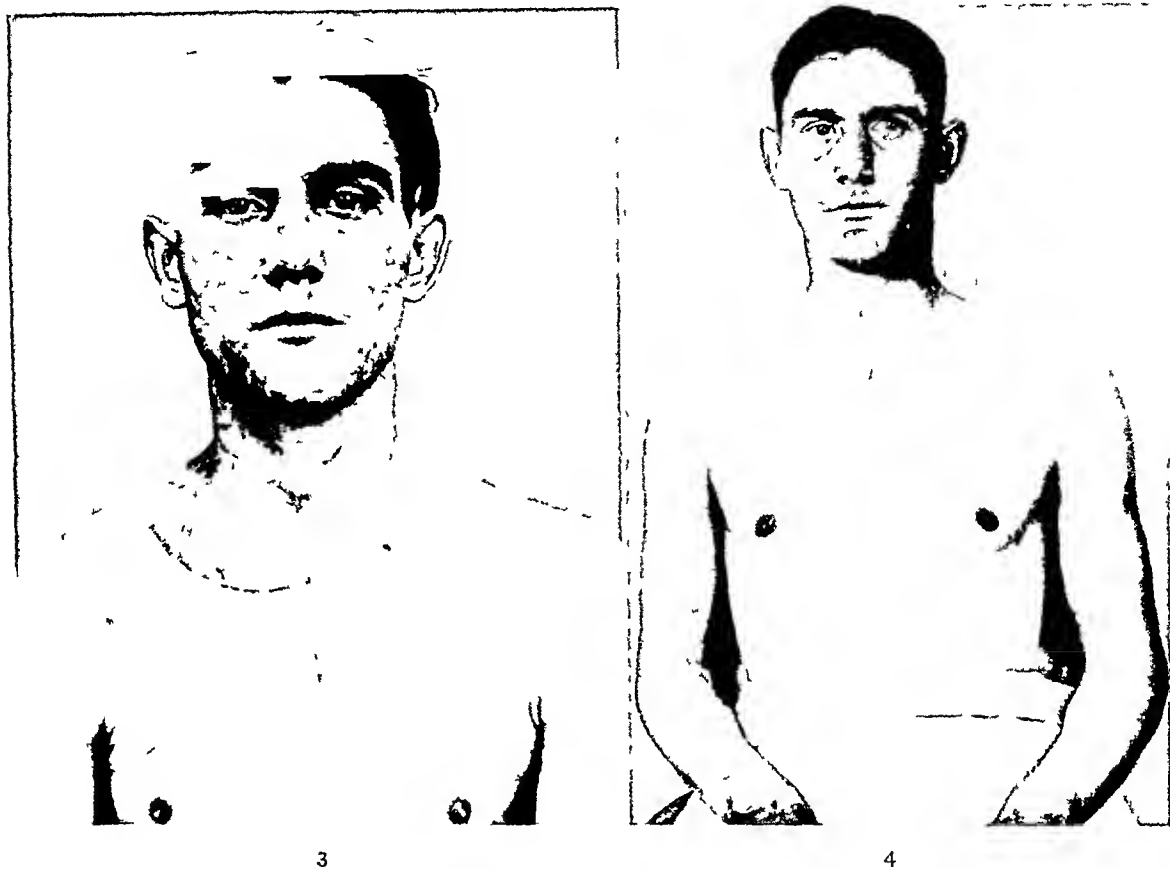


FIG 3 —Patient four weeks after ligation of the innominate artery. Note persistence of enophthalmos and subsidence of large swelling.
 FIG 4 —One year after operation. Slight enophthalmos still present. The swelling has completely disappeared.

however, that the experiences of Makins were entirely against such a practice, and a number of experiments have been performed to substantiate the claim that it is better to occlude also the satellite vein when any of the large arterial trunks require ligation. Van Kead⁴ reported animal experiments in which plethysmographic tracings demonstrated clearly that, after a previous fall in pressure due to ligation of the artery, a slight rise in the blood-pressure of the limb followed the application of a ligature to the main vein.

Drummond,⁵ likewise, made some interesting observations on animals in which segments of small bowel had been treated by two different methods. One segment was deprived of its blood supply by ligating the artery alone. A second segment in the same animal was treated by ligating both the artery and the vein. In three instances a definite ring of gangrene appeared, limited to the segment in which only the artery was ligated, whereas no change

occurred in the segment of bowel in which both artery and vein were occluded. Additional corroborative evidence to support Makins' point of view is furnished by Brooks and Martin⁶ who performed ligation of the common iliac artery in the rabbit with and without ligation of the satellite vein. They found in a series of thirty-nine experiments that in those animals in which the artery alone was occluded, 71.5 per cent developed gangrene of some degree, whereas in those animals in which the accompanying common iliac vein was also ligated, only 33.3 per cent developed any manifestation of gangrene.

There is evidence also that the function of the limb is less likely to be impaired following simultaneous ligation of artery and vein. Doctor Halsted⁷ records two instructive observations: the excision of a large ilio-femoral aneurism including the deep and superficial veins, was followed by perfect function in the limb of a stevedore accustomed to the hardest kind of labor. In striking contrast to this was the result obtained in another patient whose common iliac artery he had ligated, but not the corresponding vein. In this instance, the patient was prevented by claudication from ever walking more than one or two hundred yards.

In a clinical study by Selirt,⁸ it was found with reference to the lower extremity, that ligation of the artery alone was followed in 20 per cent of his cases by gangrene, whereas ligation of both the artery and vein was followed in only 9 per cent by gangrene. With reference to the upper extremity he found that ligation of the artery alone resulted in gangrene in 7.8 per cent of the cases and ligation of both artery and vein resulted in no gangrene. He attributes the larger percentage of gangrene in the lower extremity to the absence of large muscle masses bridging the knee as compared with those bridging the elbow.

In a statistical summary by Heidrich⁹ we find that among 995 ligations of the large arteries alone, gangrene occurred 154 times, a percentage of 15.4, and among 198 ligations of both artery and vein, gangrene occurred 17 times, or a percentage of only 8.5.

With these facts before us, there would seem to be no doubt as to the proper procedure which should be followed whenever one of the large arterial trunks requires ligation. One should invariably ligate also the accompanying vein.

A consideration of the hydraulic principles governing blood flow under such conditions leads to the assumption that the site of this ligation should be proximal to the site of the arterial ligation. If, for example, the superficial femoral artery were ligated in Hunter's canal, the collateral circulation would be provided mainly through the deep femoral artery. Normally, the blood flowing through this artery passes through a given set of capillaries in the thigh and leaves the limb by its accompanying vessel, the deep femoral vein. If this vein remains unobstructed, the pressure in the capillary bed of the thigh would be low, and the small volume of collateral blood from the deep femoral artery might readily flow through the accustomed route, with

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its area of low resistance, back to the heart, avoiding entirely the more distal peripheral bed. If, however, in the presence of a ligation of the superficial femoral artery, the common femoral vein be ligated, the resulting increased resistance in the capillary bed of the thigh, together with the lessened resistance in the artery below the ligature, would direct the blood from the deep femoral artery into the small arterial communicating channels of the perforating arteries, thence into the anastomotic vessels about the knee-joint and into the main femoral or popliteal artery leading to the more distal capillary bed. *It seemed from this point of view that ligation of the popliteal artery, or of the superficial femoral artery just proximal to the popliteal space, should under certain circumstances be accompanied not by ligation of the popliteal vein or of the superficial femoral vein, but by ligation of the common femoral vein above the entrance of the deep femoral branch or even above the entrance of the greater saphenous vein.* This procedure would increase the capillary resistance in the thigh and by directing the full force of the collateral circulation into the anastomotic channels about the knee-joint, should lessen the probability of gangrene.

In support of this view convincing experimental evidence may be presented. As previously noted, Brooks and Martin encountered gangrene in 71.5 per cent of their experimental rabbits in which the common iliac artery alone was ligated. When both common iliac artery and vein were ligated, 33.3 per cent of the animals developed gangrene with a high mortality. Holman and Edwards,¹⁰ with the above theoretical considerations as the basis for their work, ligated the common iliac artery simultaneously with ligation of the inferior vena cava three centimetres above the confluence of the common iliac veins. Twenty-eight rabbits were so treated followed in only two instances by a limited gangrene of the right extremity, and in each of these instances the operation was complicated by hemorrhage which proved difficult to control. As compared with the results obtained by Brooks and Martin there is no question of a lessened gangrene in this series, a percentage of 7.1 instead of 33.3.

The circumstances demanding the ligation of the vein proximal to arterial ligation would presumably be dependent upon the extent to which collateral circulation had already developed as the result of the lesion which necessitated the ligation. Proximal ligation of the vein would be applicable in all cases which entailed an acute shutting off of the arterial supply, as in traumatic injury to vessels. If for any reason a collateral circulation had already developed, its application would probably be less imperative and perhaps accompanied by a certain degree of danger of swelling of the limb. In the experimental animal there was no swelling of the left limb following the ligation of the vena cava although the arterial supply of the limb remained intact.

This principle is subject to further application. If the artery and vein are ligated simultaneously at the same level, and gangrene later impends—as occurs in 8 to 10 per cent of the clinical cases—it would be in order to

ligate the vein immediately at a point considerably nearer the heart—a procedure to be carried out promptly before true gangrene had supervened

Ligation of Artery Proximal to Arteriovenous Fistula—A further clinically known objection to the ligation of the artery alone proximal to an arteriovenous aneurism was corroborated recently by experimental observations. Arteriovenous fistulæ were produced between the common femoral vessels of the dog. Two weeks later the femoral artery was ligated just proximal to the fistula, resulting in a temporary obliteration of the characteristic thrill and bruit of the fistula. No gangrene supervened, but within a week the thrill and bruit had returned with unabated intensity, due to the very evident development of an extensive collateral circulation. The blood-pressure below the fistula could not be measured immediately after ligation of the artery, but within two weeks it had risen to 110 systolic and 90 diastolic, as recorded by a Pachon sphygmomanometer. Three similar experiments demonstrated the futility of curing such fistulæ in dogs by ligation of the proximal artery alone. It may be inferred, therefore that even if ligation of the proximal artery should not produce gangrene, it would not be effectual in eliminating the fistula.

A more radical procedure is required for the cure of a varicose aneurism, and the most effective methods at our disposal are

(1) Reestablishment of the artery and vein by separation and suture of the two openings. This procedure is applicable in cases of short duration, but it is not always practicable in those of long duration due to extensive calcium deposits in the wall of the artery.

(2) Quadruple ligation of the main vessels proximal and distal to the fistula with excision of the communication. This procedure Makins found effective whenever used and it is, above all others, the operation of choice, a view recently sustained also by Reid¹¹

(3) The method of Matas,¹² which sutures the opening in the artery by approaching it through the dilated vein. Although applicable in certain instances this method, too, may be found unsafe and impracticable because of the altered and weakened state of the arterial wall at the site of the fistula.

Division of Large Arteries Between Ligatures Preferable to Ligation in Continuity—A further point to be considered in the surgery of the large arteries pertains to the question of ligation in continuity, which remains still a matter of dispute. Thus wrote Ballance and Edmunds¹³ in 1886

"The earlier surgical writers, Galen, Paulus Aeginata and others recommend the application of two ligatures and the division of the artery between them, an operation which now bears the name of Abernethy (1827), but many others have practiced it. This way of tying an artery probably originated in the observation that arteries in amputation stumps are less prone to secondary hemorrhage than those tied in continuity, a fact which explains the favour with which the operation has lately been received, and gives the reason for its attempted revival. The validity of this analogy was questioned by Sir Charles Bell sixty years ago, and the procedure appears unnecessarily severe."

However, it has been observed occasionally that ligation in continuity is followed by a reestablishment of the arterial lumen with subsequent recur-

rence of the lesion which prompted the ligation. To prevent this, Horsley¹⁴ has recently advocated again the double ligation of the artery with division of the vessel between the ligatures.

The danger of this reestablishment of the lumen is of less importance than the probability of secondary hemorrhage through erosion of the vessel wall. The development of infection would lead almost inevitably to such a result, but *even in the absence of infection* many of the fatalities following ligation in continuity may be attributed to an erosion of the wall. There is evidence that this erosion is less likely to occur if the vessel is ligated at two points and divided between ligatures. Such division permits a marked retraction of the vessel due to its elastic elements, with an actual thickening of its walls. The resulting increased elasticity of this blind arterial end absorbs the force of each pulsation, and effectively dissipates the pulsatile pressure which in ligation in continuity spends itself against the ligature itself, with frequently disastrous results. Recent experiments have shown that the abdominal aorta when ligated will retract $2\frac{1}{2}$ or 3 cm. with an actual perceptible thickening of its walls. Reichert's¹⁵ experiences confirm this observation.

Partial Ligation of Large Arteries to be Avoided—The *partial* ligation of large arteries is a dangerous procedure. This was brought home to us recently in a number of experiments¹⁶ in which the pulmonary artery and aorta were partially ligated just beyond the pulmonic and aortic valves in an effort to simulate stenosis of these vessels. Out of five partial ligations of the aorta only one experiment went to full completion because of rupture of the vessel wall with fatal hemorrhage.

Simultaneous Ligation of Carotid Artery and Jugular Vein—Our discussion so far has been directed mainly to a consideration of the effect of ligating the large vessels leading to the extremities. There remains also the question of ligation of the common carotid artery. This procedure is frequently followed by a hemiparesis of the opposite side due to nutritional disturbances in the cerebrum. Additional clinical phenomena that have been observed following ligation of the common carotid are convulsions, drowsiness, coma, cardiac and respiratory irregularities, fall in temperature, blindness, diplopia, and motor and sensory losses on the opposite side.

A full discussion of the cerebral changes that follow the ligation of the common carotid artery is presented by Zimmermann¹⁷. He quotes Pilz¹⁸ who gathered together 600 cases of ligation of the common carotid artery, 32 per cent of whom presented cerebral symptoms. Zimmermann records seventy ligations of the carotid performed since the introduction of asepsis, of which 26 per cent were followed by cerebral symptoms. One may well speculate what results could now be achieved with a simultaneous ligation of both the common carotid artery and internal jugular vein. Indeed, arguing by analogy from the better results obtained by ligation of both vessels in the extremities, Makins very emphatically advises occlusion of the jugular vein whenever ligation of the common carotid artery is considered. Proping¹⁹ in discussing the causes of gangrene following ligation of the great

arterial trunks, reports two instances in which simultaneous ligation of the jugular and carotid vessels was unattended by cerebral disturbances. Halsted held that ligation of the common carotid artery could be performed with impunity in the young, and that the incidence of cerebral disturbances following ligation of the common carotid increased with age.

Simultaneous Ligation of Innominate and Carotid Arteries for Subclavian Aneurism—It is important to note also that Thompson²⁰ presents evidence indicating that when circumstances demand ligation of the innominate artery, it is well to ligate also the common carotid artery. He found that only 41 per cent of seventeen cases recovered following ligation of the innominate alone, whereas 66 per cent of twelve cases recovered following ligation of both the innominate and carotid arteries. He contends that ligation of the carotid artery is indicated because "it diminishes still further the flow of blood through the aneurism and thereby promotes consolidation and it prevents an excessive drain of blood from the circle of Willis, thus avoiding cerebral anæmia." The ligation of both carotid and innominate arteries would probably increase the percentage of subsequent gangrene in the limb unless the innominate vein were also ligated.

Importance of Avoiding Sepsis Drainage Contra-indicated—The success of operations upon the large vessels depends in great measure upon the avoidance of sepsis. The strictest precautions against infection must be followed throughout, particular attention being paid during a prolonged operation to exclude the skin from the operative field. Drainage in vascular surgery must be scrupulously avoided. Through the insistence and example of the late Professor Halsted, the drainage of clean wounds of whatever nature is becoming less and less a necessary part of modern surgical technique. Many surgeons are still loath to discard such drainage, but the disciples of Halsted no longer hesitate to close completely all clean wounds, including those following thyroidectomy, herniotomy, amputations, or the excision of large tumors. The better healing and lessened incidence of infection that follows such a procedure is easily demonstrable. For identical reasons it cannot be too emphatically stated that in the surgery of the large vessels the packing and drainage of wounds is inviting almost certain disaster. Should the wound at any time following operation fill up with fluid, it is a simple matter to evacuate it under strictly sterile precautions. Only in the presence of obvious infection should a drain or irrigating tube be introduced following such an evacuation of a wound.

SUMMARY

Recapitulating the points which seem to require special emphasis in the surgery of the large vessels, the following considerations are presented.

Ligation of one of the large arterial trunks should be accompanied also by occlusion of the accompanying vein. From experimental evidence, a new principle in the simultaneous ligation of artery and vein seems admissible.

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Under certain circumstances it is preferable to ligate the vein *proximal* to the site of the arterial ligation, *e g*, ligation of the popliteal artery should be accompanied by ligation of the common femoral vein above the entrance of the deep femoral and saphenous branches. In the experimental animal, the incidence of gangrene was greatly decreased by the application of this principle.

A coarse ligature such as a broad tape should be applied to the large arterial trunk rather than fine ligatures, since the latter cut through the arterial wall with distressing rapidity.

If feasible, division of an artery between ligatures should supersede ligation in continuity, even of the abdominal aorta, primarily because of the lessened possibility of fatal erosion of the arterial wall.

Partially occluding ligatures and crushing ligatures applied to large vessels are both equally and highly dangerous because of fatal rupture of the wall of the vessel. The ligature should be tied so as to occlude the artery, but not to crush it. Likewise it would seem better not to use a partially constricting ligature central to a totally occluding one.

Proximal ligation of the artery for an arteriovenous fistula is contraindicated not only because of the imminent danger of distant gangrene, but also because it is entirely futile in eliminating the fistula, should gangrene be averted.

Following operations upon the large vessels, the wound should be completely closed without drainage.

BIBLIOGRAPHY

- ¹ Makins, G. H. Gunshot Injuries to the Blood-vessels. 1909, John Wright & Sons, Bristol, England.
- ² Holman, E. Experimental Studies in Arteriovenous Fistulas, I. Blood Volume Variations. Arch Surg, Nov, 1924, vol ix, p 822.
- ³ Holman, E. Arteriovenous Aneurism, Clinical Evidence Correlating Size of Fistula with Changes in the Heart and Proximal Vessels. ANNALS OF SURGERY, Dec, 1924, vol lxx, p 801.
- ⁴ Van Kead. Quoted by Makins.
- ⁵ Drummond. Quoted by Makins.
- ⁶ Brooks, B., and Martin, K. Simultaneous Ligation of Vein and Artery. An Experimental Study. Journal A. M. A., June 9, 1923, vol lxxv, p 1678.
- ⁷ Halsted, W. S. Ligations of the Left Subclavian Artery in its First Portion. Johns Hopkins Hospital Reports, vol xxi, p 1921.
- ⁸ Sehrt, E. Ueber die kunstliche Blutleehre von Gliedmassen und unterer Korperhalfte sowie ueber die Ursache der Gangran des Gliedes nach Unterbindung der Arterie allem. Med. Klin., Berlin, 1916, vol xii, p 1338.
- ⁹ Heidrich, L. Ueber Ursache und Haufigkeit der Nekrose bei Ligaturen grosser Gefassstamme. Beit zur klin. Chir., vol cxliv, 1921, pp 607-638.
- ¹⁰ Holman, E., and Edwards, M. A New Principle in the Surgery of the Large Vessels. Ligation of the Vein Proximal to the Site of Ligation of the Artery. An Experimental Study. (In Press.)
- ¹¹ Reid, M. R. The Treatment of Arteriovenous Communications. Arch Surg, Aug, 1925, vol vi, p 237.

- ¹² Matas, R Some Experiences and Observations in the Treatment of Arteriovenous Aneurisms ANNALS OF SURGERY, April, 1920, vol 141, p 403
- ¹³ Ballance, C A, and Edmunds, W The Ligation of the Larger Arteries in Their Continuity Med Chir Trans, London, 1885-1886, vol 144, p 443
- ¹⁴ Horsley, J S, Jr Healing of Arteries After Different Methods of Ligation Journal A M A, Oct 17, 1925, vol 1444, p 1208
- ¹⁵ Reichert, F L An Experimental Study of the Anastomotic Circulation in the Dog Johns Hopkins Hospital Bulletin, Dec, 1924, vol 2225, p 385
- ¹⁶ Holman, E, and Beck, C S The Physiological Response of the Circulatory System to Experimental Alterations III The Effect of Aortic and Pulmonic Stenosis Jour Clin Invest (In Press)
- ¹⁷ Zimmermann, W Ueber die Gehirnweichung nach Unterbindung der Carotis communis Beitr Z Klin Chir, 1891-1892, vol viii, p 364
- ¹⁸ Pilz Zur Ligatur der Carotis communis Archiv fur klin Chirurgie, 1868, Band 14, p 257
- ¹⁹ Propping, K Ueber die Ursache der Gangran nach Unterbindung grosser Arterien Munchener Medizinische Wochenschrift, 1917, vol 144, p 598
- ²⁰ Thompson, J E Ligature of the Innominate Artery for Cure of Subclavian Aneurisms ANNALS OF SURGERY, June, 1915, vol 14, p 641

CONTRIBUTION TO PLASTIC SURGERY

REMOVAL OF SCARS BY STAGES, AN OPEN OPERATION FOR EXTENSIVE
LACERATION OF THE ANAL SPHINCTER, THE KONDOLEON
OPERATION FOR ELEPHANTIASIS

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SIMPLE surgical procedures are often used and forgotten, and for this reason I wish to report in this symposium on plastic surgery two simple but useful surgical measures which, no doubt, have been used before but to which I am unable to find references. I also wish to discuss certain modifications of the Kondoleon operation which have proved valuable in improving the end-results in the treatment of elephantiasis.

REMOVAL OF SCARS BY STAGES

The skin, probably on account of its elastic fibres, easily stretches when put under tension. We see examples of this in large tumors, goitres, and in cases of elephantiasis after the oedema has been reduced by bandages and rest in bed. It is possible to take advantage of this characteristic of the skin and to remove scars situated in certain regions, where it would be inadvisable to use grafts in stages, allowing the skin after each operation to stretch and again become loose and movable. From the appearance of scars following skin grafts, from the color of the skin in these areas, or from the border

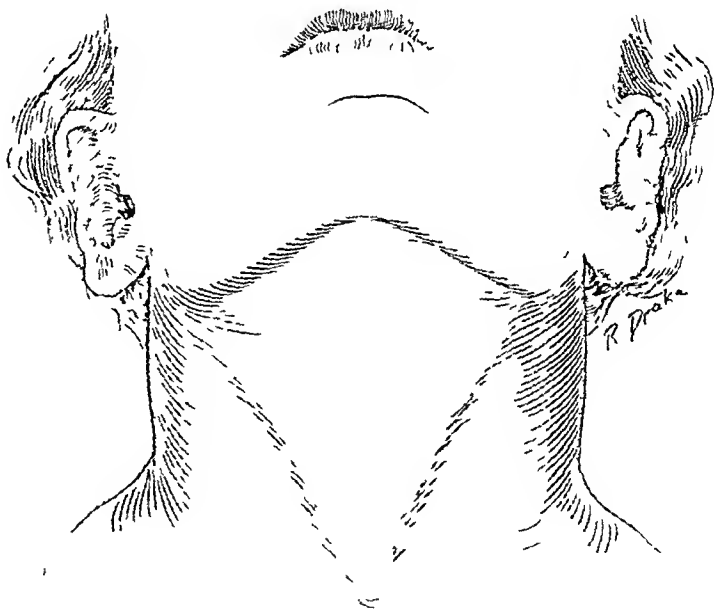


FIG. 1.—Appearance of Röntgen-ray burn before operation

of the graft when thick grafts have been applied, one can usually tell that grafts have been used. The appearance of the scar for which the original operation was performed may have been greatly improved, but the result is not always that desired by the operator.

CASE I.—The patient was a woman, aged thirty, who had been affected with goitre since the age of sixteen. From many exposures to the Röntgen-ray in the treatment

* Read before the American Surgical Association, May 24, 1926

of this goitre, a superficial burn resulted and the scar which followed involved almost the entire anterior surface of the neck from the hyoid bone nearly to the clavicle. Its appearance was so unsightly that the young woman was quite sensitive about it and to hide it wore, at all times, a scarf or a high collar. She had repeatedly consulted sur-

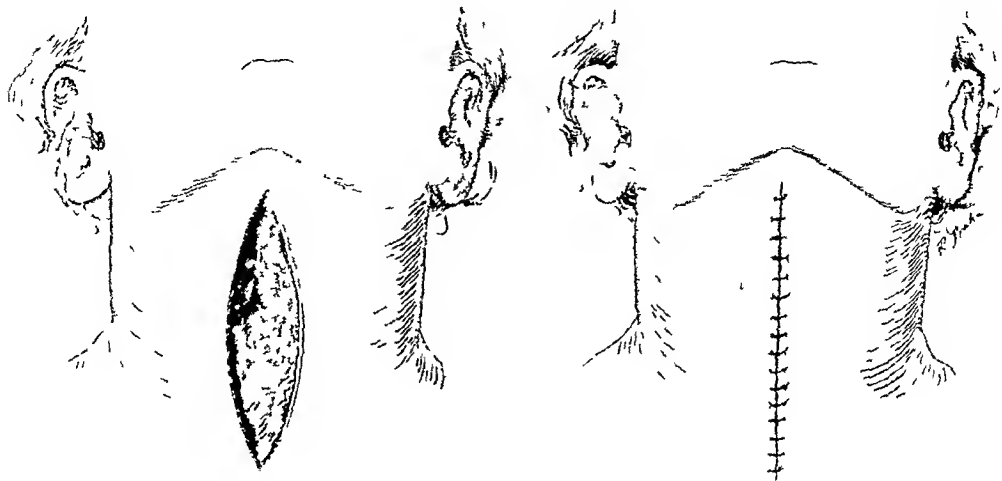


FIG 2 —First stage of the operation. A small portion of the burned area excised and the wound closed. Surgeons in the hope that it could be removed, but had always been advised against operation since they felt that the skin graft which would be necessary after removal of the scar would be almost as unsightly as the burn.

Examination showed the scar of a superficial burn with movable skin which was unattached to the deeper tissues. It was quite red in appearance and showed many large, dilated capillaries. Apparently nothing short of complete excision of the burn would improve the appearance of the neck. It was accordingly suggested that the burn be removed by stages, to which method of treatment the patient gladly consented.

As much of the skin as could be removed and still allow closure of the edges of

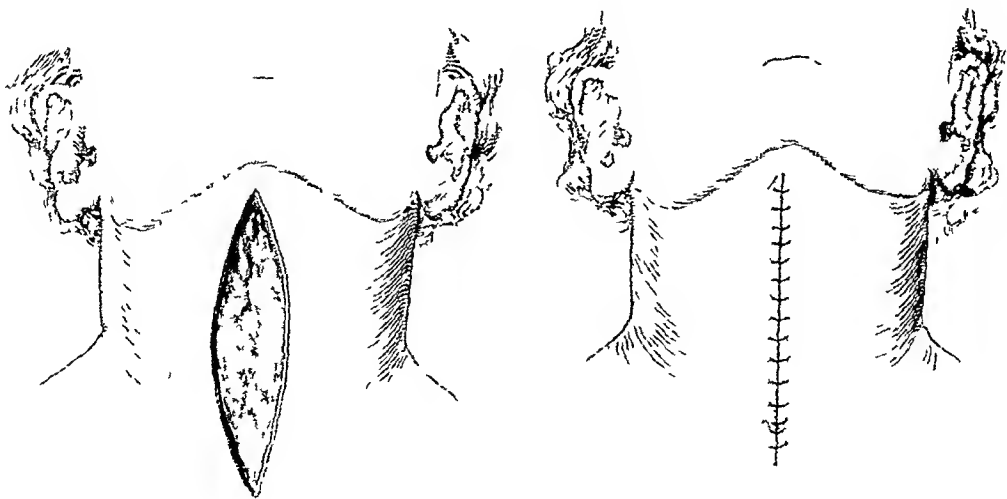


FIG 3 —Second stage of operation (repetition of first stage)

the wound without tension was removed. The skin and superficial fat only were removed and special effort was made to avoid undermining the skin in order to prevent adhesions between it and the deeper structures which would later prevent the skin being stretched by massage, and so forth. It was possible in this way to remove about one-

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third of the scar. Following the operation, the patient stretched the skin by movements of the neck and by massage. On her return six months later, the skin was as loose and pliable as it was at the first operation and the scar was only two-thirds as large. A similar operation was then performed, to remove about one-half of the remainder of the scar. The patient returned again after six months and, at a third operation, the remaining portion of the scar was removed. Now only a single line may be seen. In this way the skin was removed from almost the entire anterior surface of the neck without a graft (Figs 1, 2, 3, and 4).

I have since employed the same method in removing an ugly scar from the anterolateral surface of the neck. The patient, a young woman, had

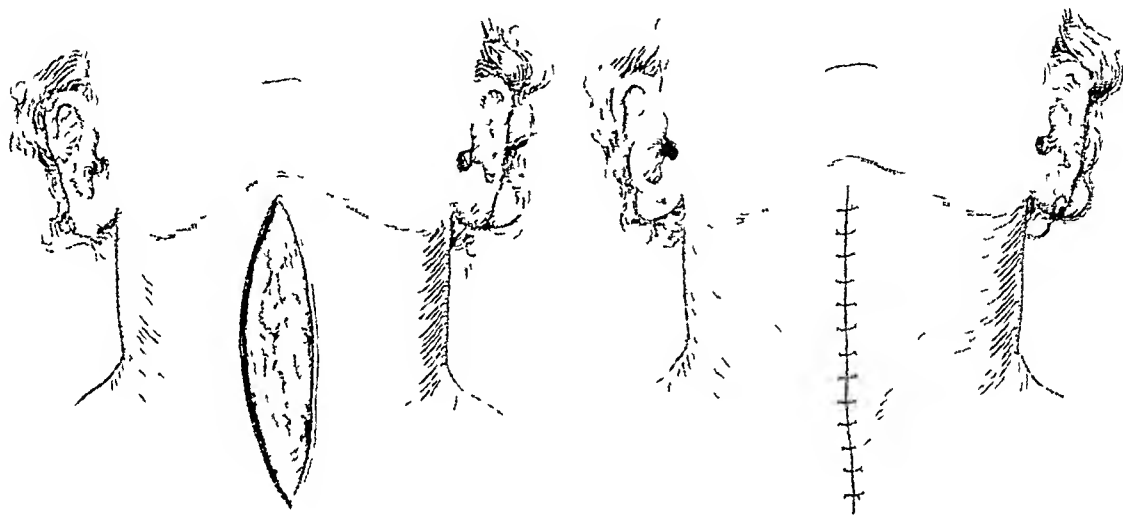


FIG 4 —Third stage of operation. Remainder of burned area excised and wound closed.

suffered a severe superficial burn following the application of a strong solution of iodine. The results of the operation were excellent.

AN OPEN OPERATION FOR EXTENSIVE LACERATION OF THE ANAL SPHINCTER

In the ordinary case in which a primary operation is performed for a tear of the external sphincter ani, the operation almost universally described in text-books is quite satisfactory and is usually followed by good results. However, an occasional case is seen in which practically the entire external sphincter has been destroyed, usually either by an infection, as is seen in perirectal abscesses, or as a result of an operation for rectal fistula.

In the type of case which I am attempting to describe, the sphincter has often been largely destroyed and the nerves supplying it usually impaired or destroyed. In many such cases it is almost impossible to draw the ends of the sphincter together without such tension as to prevent satisfactory healing. The anus, too, in such cases, is necessarily so tightly closed in bringing the ends of the sphincter muscle together that too small an opening is left and the muscle ends usually separate during the first act of defecation. Should satisfactory healing occur, the normal control of the muscle is not regained, and the anus cannot be closed even by voluntary efforts.

For some years I have, in treating anal fistula, divided the tissues anterior to the fistulous tract and severed the external sphincter over a probe. In

order to prevent wide separation of the sphincter ends and still be able to pack the fistulous tract with gauze so as to allow the wound to heal from the bottom by granulation, I have sutured the cut ends of the external sphincter muscle to the internal sphincter (levator ani muscle). An operation of this sort has usually cured the fistula and at the same time has established excellent control. The effect on control of bowel movements has been so satisfactory that I have extended the use of the operation and now follow practically the same method in operating for complete lacerations of the



FIG 5 — Exposure of levator ani muscle

perineum and in repairing the anal sphincter when it has become incompetent from any cause.

Technic — A curved transverse incision is made just above the anus or along the vaginocutaneous margin, and the levator ani muscle isolated. This muscle is sutured over the anterior rectal wall, as in an ordinary perineorrhaphy. The ends of the external sphincter which are often widely separated are isolated and sutured to the levator ani, the ends being brought as closely together as possible without too much tension. If sutured under too much tension, satisfactory healing will not occur, as the tissues will slough and the sutures fail to hold. The ends of the muscle are usually brought close enough together to close the anus so that it fits snugly around an index finger introduced into the rectum. The wound is left open and packed with iodoform gauze, as is done in operations for rectal fistula. The gauze is usually held in position by a suture placed through the edges of the skin and loosely tied in such a way that the edges of the skin are left wide open. After seven or eight days it may be removed and a healthy granulating surface usually

results which slowly heals. The scar tissue which forms in the healing process unites fairly satisfactorily the edges of the external sphincter. If the nerve supply to this muscle is uninjured, the patient usually develops normal control, if it has been injured, normal control will not be regained but the patient will usually be able to close the external sphincter voluntarily by elevating the levator ani through efforts to close the vagina or to lift the rectum upwards. Through this voluntary effort, patients are usually able to close the anus fairly tight upon a finger introduced into the rectum and can

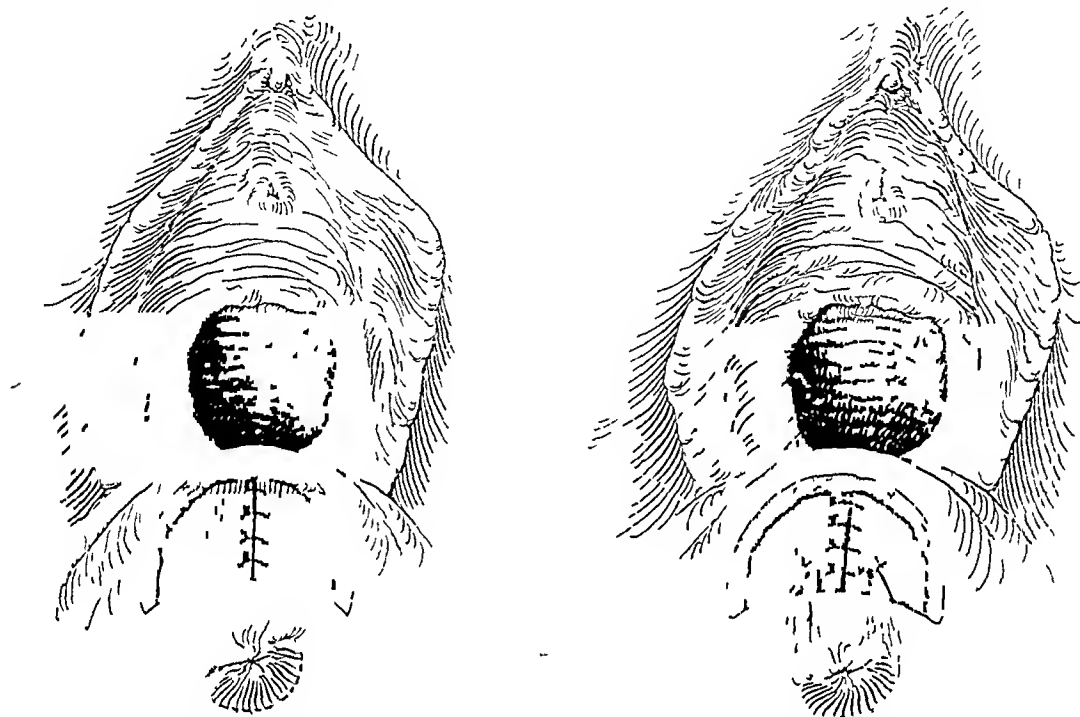


FIG. 6 —Levator ani muscles sutured together and remaining portion of anal sphincter sutured to them

usually keep the anus closed sufficiently long to control gases and faeces until the toilet can be reached. The ability to close the anus by voluntary effort gives the patient great mental relief. The operation differs from that ordinarily performed for complete lacerations, as I have seen it described and carried out. In the common operation, the ends of the sphincter are merely sutured together, often under great tension, without any attempt to suture them to the levator ani. The method I have described tends to give much better voluntary control, the only control that can be expected in certain cases in which the sphincter has largely disappeared and its nerve supply been injured (Figs 5 and 6).

More satisfactory results are obtained when patients are given castor oil forty-eight hours previous to the operation and allowed only water, fruit juices and sugars after the oil has acted. I usually induce constipation by administering paregoric before the operation. This medication is also continued for about ten days after the operation, during which time patients are given only water, fruit juices and broth. After ten days oil enemas, consisting of 180 cc of olive oil are given by rectum morning and night and a

mild laxative, such as milk of magnesia, is administered several times a day until satisfactory bowel movements have occurred

CERTAIN MODIFICATIONS OF THE KONDOLCON OPERATION FOR ELEPHANTIASIS

These changes in the Kondoleon operation have been made after nearly ten years' experience with the operation and contribute to the success of the end-results. At the present time I feel that this operation is of much value

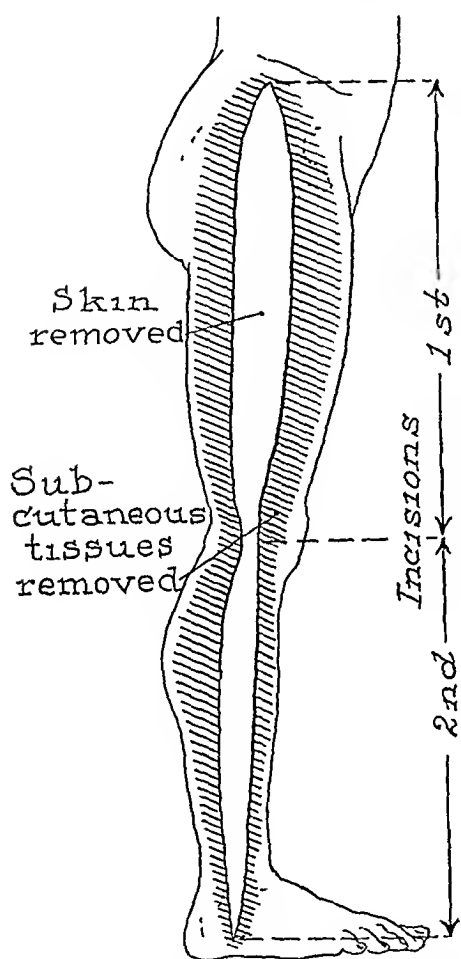


FIG 7 —Strip outlined and undermined areas shaded

The operation cannot be considered one which will restore a perfectly normal limb, but as one through which the progress of this disease may be controlled and the size of the limb greatly diminished. Briefly, it may be stated that, although we see congenital elephantiasis, the so-called "idiopathic elephantiasis," which is usually seen in this country, is a sequel to partial or complete obstruction of the inguinal lymph-nodes. Elephantiasis is always preceded by simple lymphœdema which progresses until it gradually merges into elephantiasis. In lymphœdema the skin is thin, without the thickened dermis and aponeurosis and the large quantities of scar tissue seen in the subcutaneous tissues in true elephantiasis. The superficial lymphatic system alone is involved even in advanced cases of elephantiasis and this system is definitely separated from the deep lymphatic system by the aponeurosis covering the muscles. The Kondoleon operation is performed with an idea of connecting these two systems by removing a large amount of this aponeurosis. At the same

time, a large amount of the skin and subcutaneous fat is removed and the skin, with a small amount of the subcutaneous fat, is allowed to become attached to the muscles. When these raw surfaces are apposed, new blood-vessels, new nerves and new lymphatics form, and the superficial lymphatic system is thus connected with the deep system.

I believe that the removal of large amounts of diseased tissue with its blocked lymphatics is one of the very important steps of the operation. Kanaval has called attention to the fact that this was suggested many years ago by Rogers of Milwaukee. Better results are obtained if much larger amounts of the aponeurosis are removed than first suggested by Kondoleon, and I feel that the more tissue removed the better the result. In order that

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large amounts of diseased tissue may be removed and the edges of the skin still be closed, patients should be carefully prepared for the operation by rest in bed for periods of from ten days to several weeks. During this time, the limb to be operated on is kept elevated and firmly bandaged so that the fluids may

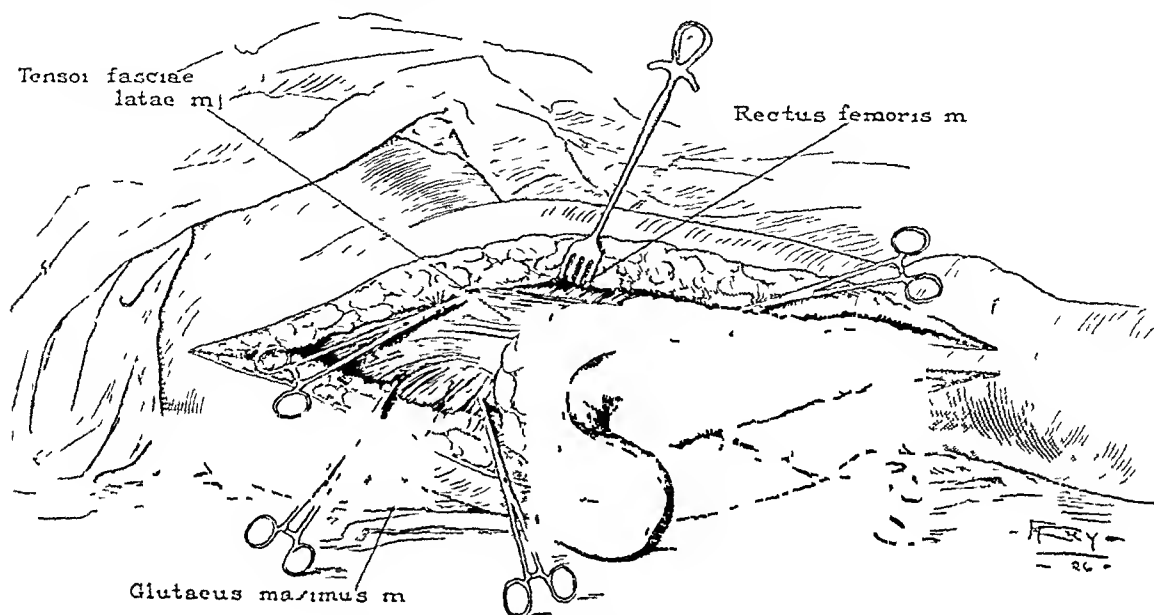


FIG 8 —Strip nearly excised, vessels clamped

be pressed out and the œdema diminished. The bandages are changed as often as they become loose and the patients are made to get up and walk rapidly down the hospital halls for a few minutes several times each day, so that the blood-pressure may be kept as near normal as possible. At the

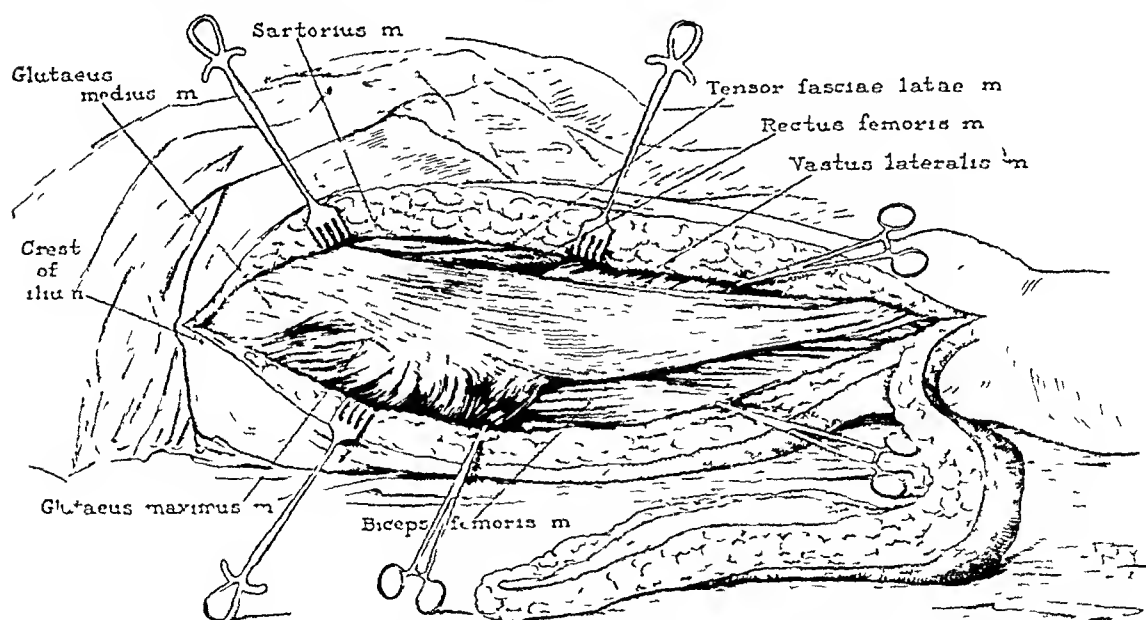


FIG 9 —Strip from thigh excised with aponeurosis attached

present time a very much more radical operation is performed than in the early cases.

Technic—A long, modified semi-elliptic incision, which includes the skin to be sacrificed, is made on one side of the affected limb. On the outer aspect

of one of the lower extremities, for instance, this incision extends from the crest of the ilium to a point a little below the external malleolus. Then, in order to facilitate wide removal of the subcutaneous fat, the skin is reflected on each side of the incision for a distance of about 6 cm. The skin is then

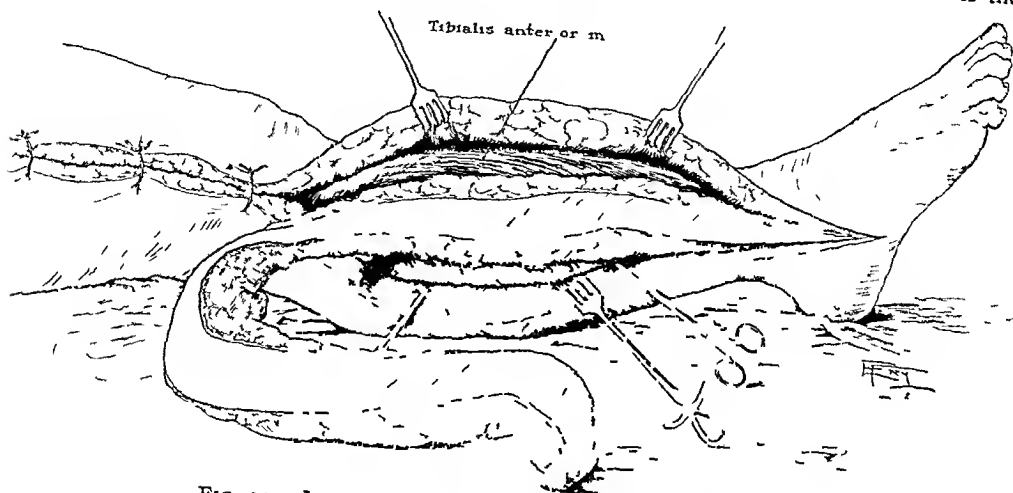


FIG 10 —Incision in thigh closed and strip ready to be removed

retracted and underneath each of the edges of reflected skin a long incision is made through the subcutaneous fat down to, and including, the aponeurosis. These incisions are made almost parallel with the original skin incision. Included between them is a quadrilateral piece of subcutaneous fat and aponeurosis. The two incisions through the aponeurosis are then connected at

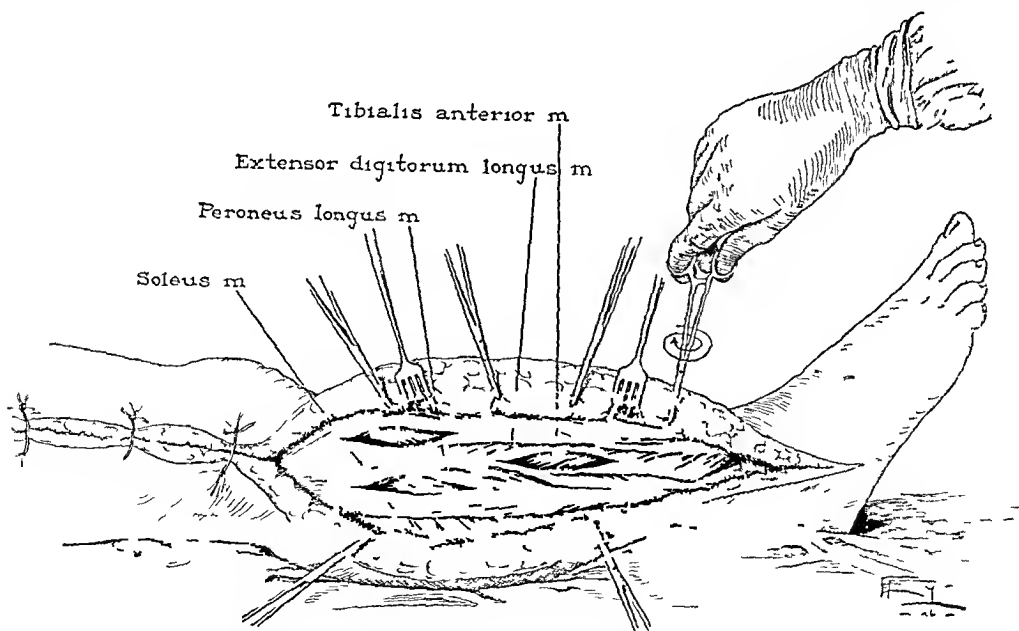


FIG 11 —Incision in thigh closed, strip removed from leg, and slits in muscles

their ends, so that the tissues to be removed are free except for the attachment of the aponeurosis to the underlying muscles. By traction on these tissues it is easy to dissect the aponeurosis from the muscles throughout the entire length of the limb and to remove in one long piece the skin, subcu-

taneous fat underneath it and aponeurosis. The skin with the small amount of subcutaneous fat is allowed to drop down on the muscles and the wound is closed with interrupted silkworm sutures without drainage. It is usually necessary to perform a similar operation on the opposite side of the limb (Figs 7, 8, 9, 10, and 11).

The operation is not devoid of danger as very severe shock often follows a radical operation of this sort. Efforts are made to prevent this, first, by keeping the blood-pressure up as near normal as possible during the pre-operative period, and by the administration of opiates, usually one-quarter grain of morphin, one-half hour before the operation, and by deep ether anæsthesia. Nerve blocking, no doubt, would also help to prevent shock, although I have never used this method. After the operation the patient is immediately treated as though severe shock were present: the head of the bed is lowered, external heat is applied, morphin is administered, and isotonic solution of sodium chloride is given subcutaneously and by rectum. From 5 to 10 minims of a 1:1000 solution of epinephrin is also administered shortly after the operation, and repeated each hour for several doses. The period during which shock develops is usually passed after from six to twelve hours.

It is best before the operation to have a distinct understanding with patients as to the result to be expected; they should clearly understand that the operation is an attempt to control a disease which grows progressively worse if left untreated and which will eventually produce tremendous deformity and often in the late stages of the disease result in death through repeated attacks of erysipelas. They should also understand that it will be necessary to use a bandage for an indefinite period after the operation. Should extensive œdema develop after operation, in spite of the bandaging, much benefit is received by an occasional rest in bed with the limb elevated and carefully bandaged.

ON THE USE OF LIPIODOL IN RELATION TO THORACIC SURGERY

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OF ALL diagnostic methods that involving the use of the Röntgen-ray is the most important, and has furnished the greatest impetus to the development of thoracic surgery. There have been, however, marked limitations to its usefulness. In bronchiectasis without much fibrosis the roentgenogram may fail to demonstrate the lesion. A pulmonary abscess cavity may be undistinguishable from surrounding pneumonitis or sclerosis. A solitary, multilocular or multiple abscesses of the lung or an empyema cavity may be entirely masked by a diffuse thickening of the pleura. The nature, extent and relations of fistulous opening in the chest wall are perhaps never demonstrable on the ordinary roentgenogram. In the study of such conditions the use of a safe and practical contrast medium, similar in principle to those used in the roentgenological examination of the gastro-intestinal and genito-urinary tracts should therefore be of the greatest value.

The introduction of bismuth paste by Beck was the first step in this direction and has proven very useful in the study of fistulae and of empyema cavities. This method is, however, not without its dangers and is not suitable for intratracheal injection. Chevalier Jackson² in 1918 reported a case in which the right bronchi were outlined roentgenographically by bronchoscopic insufflation of bismuth. In 1920, Lynch³ reported two cases of lung abscess outlined by a similar method. The limitations in the distribution of the powder and the necessity of bronchoscopy in its introduction, however, would probably have prevented the wide adoption of this method even if a safe and practical contrast medium and a simple method for its use had not been found.

Such a medium and method was introduced by Sicard and Forestier.⁴ In 1921 they noticed that a preparation of iodine and oil (lipiodol), developed by Lafay for intramuscular iodine medication, was opaque to the X-ray. They conceived the idea that because of this opacity and the fact that it was entirely non-irritating to the tissues, it might be used to advantage in the radiosopic examination of the various body cavities. After a series of animal experiments, they proceeded to use it on patients, injecting it into the subarachnoid space, the nasal sinuses, the urethra, bladder, kidney pelvis, fistulous tracts, and into the bronchial tree. (See Fig. 1.) Valuable information was obtained from the roentgenogram taken after the injections and in none (save in one case of injection into the cerebral ventricle) were unfavorable complications or signs of irritation noted.

* Read before the Western Surgical Association, October 15, 1926

LIPIODOL IN RELATION TO THORACIC SURGERY

The preparation is 40 per cent metallic iodine in a base of poppy-seed oil. The iodine is so intimately combined with the oil that it cannot be detected by the ordinary starch test. It is a relatively light oil of a specific gravity of 1.350. It is practically odorless and tasteless, of a light amber color, and is translucent. When exposed to the light for any length of time iodine is set free and the mixture becomes darker. It is then irritating to the tissues.

The iodine is also set free rapidly by the alkaline intestinal juices and consequently if more than a few cubic centimetres are allowed to enter the alimentary tract iodism may result. In all other cavities and tissues the absorption of the oil and the freeing of iodine is so gradual that iodism

will not result.



FIG 1.—Röntgenogram of normal lungs after injection of lipiodol. This patient had a persistent cough and symptoms suggesting the dry type of bronchiectasis.

Its Use in the Different Types of Thoracic Disease—There are certain types of disease in which the method is especially valuable. First among these should be placed bronchiectasis, and second that group of long-standing suppurative processes in which the whole affected portion of the lung, either because of fibrosis, pleural thickening, or fluid, presents a more or less diffuse clouding and in which the physical findings are similarly masked. (See Figs 2 and 3.) In some cases of these conditions the clouding is so dense that even the lipiodol does not produce a contrast shadow. In most instances, however, it shows the nature of the lesion where all other methods fail.

Bronchiectasis—In bronchiectasis one is confronted with a patient who is raising quantities of purulent sputum and yet whose physical examination and X-ray pictures (see Fig 9) may give little evidence of the lesion. This is partly because uncomplicated bronchiectasis produces few changes that are detectable by the roentgenogram and partly because the lesions, occurring

usually in the lower lobes, may be masked by the shadows of the heart or diaphragm.

To be operable bronchiectasis must be unilateral. It has often been impossible to tell from physical findings and roentgenogram whether both lungs or only one are affected. A few râles in the better lung may mean extensive involvement or may mean nothing at all, and on the other hand we have found that complete absence of physical and roentgenogram signs does not mean that pathology is not present. During the past months we have made it a routine to make lipiodol injections on both sides.

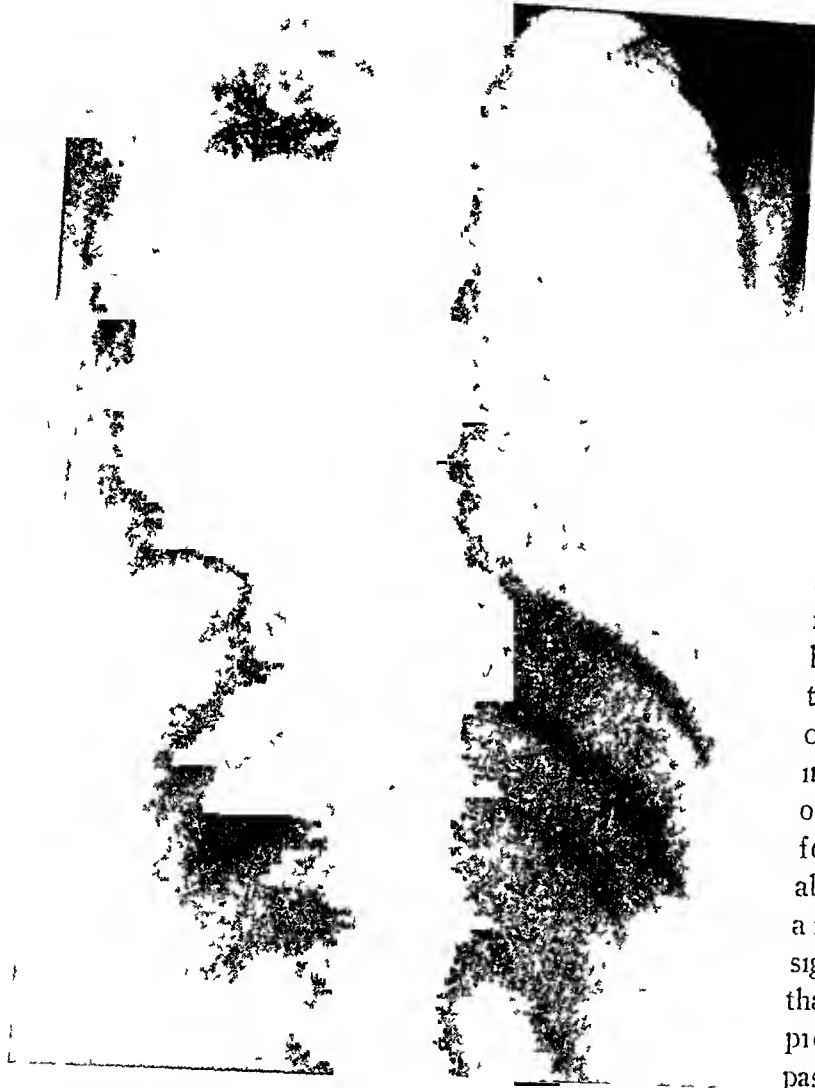


FIG 2—Roentgenogram after injection of lipiodol of girl aged eleven years who had had chronic cough and a small amount of sputum for a year. The plain plate showed merely an area of increased density in the region of the right middle lobe. The physical signs were merely those of consolidation.

In considering surgical treatment in unilateral cases, it is important to know the extent and nature of the dilatations, their relations to the diaphragm and hilus, and the presence and location of any large sacculations (See Figs 4, 5, 6, 7, 8, 9 and 10).

One must bear in mind also that in bronchiectasis the sputum is the result of a complication and is not a necessary manifestation of the essential pathology. It is only when the dilated bronchi become the seat of a purulent bronchitis that sputum is produced. Some cases in which bronchiectasis has been demonstrated at necropsy had never had the characteristic cough and

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purulent sputum, others have it only during the winter months and a fairly large per cent of those who have been studied after the disease was fully developed give a history of having had a longer or shorter free interval following the etiological disease in which a non-productive cough was the only symptom. Bezancon⁵ has called this the dry type of bronchiectasis. One can readily see that in these cases lipiodol plates are the only means

of making the diagnosis. If the injection proves eventually to be as innocuous as it now seems it will doubtless be indicated in all patients, especially children, in whom a cough persists after measles, pertussis or pneumonia.

A diagnosis of bronchiectasis has usually been made in these cases only after years of cough and sputum.

Were the diagnosis

made when the process was incipient, before chronic infection and repeated acute attacks had caused extensive pathological changes, much might be accomplished by conservative treatment, especially in children, in whom the ability to repair pulmonary injury is marked. Bronchiectasis may be another disease in which early diagnosis and intelligent prophylaxis is the key to successful treatment.

Lung Abscess—Most cases of solitary lung abscess are readily localized by the physical findings and roentgenogram. A complicating bronchiectasis

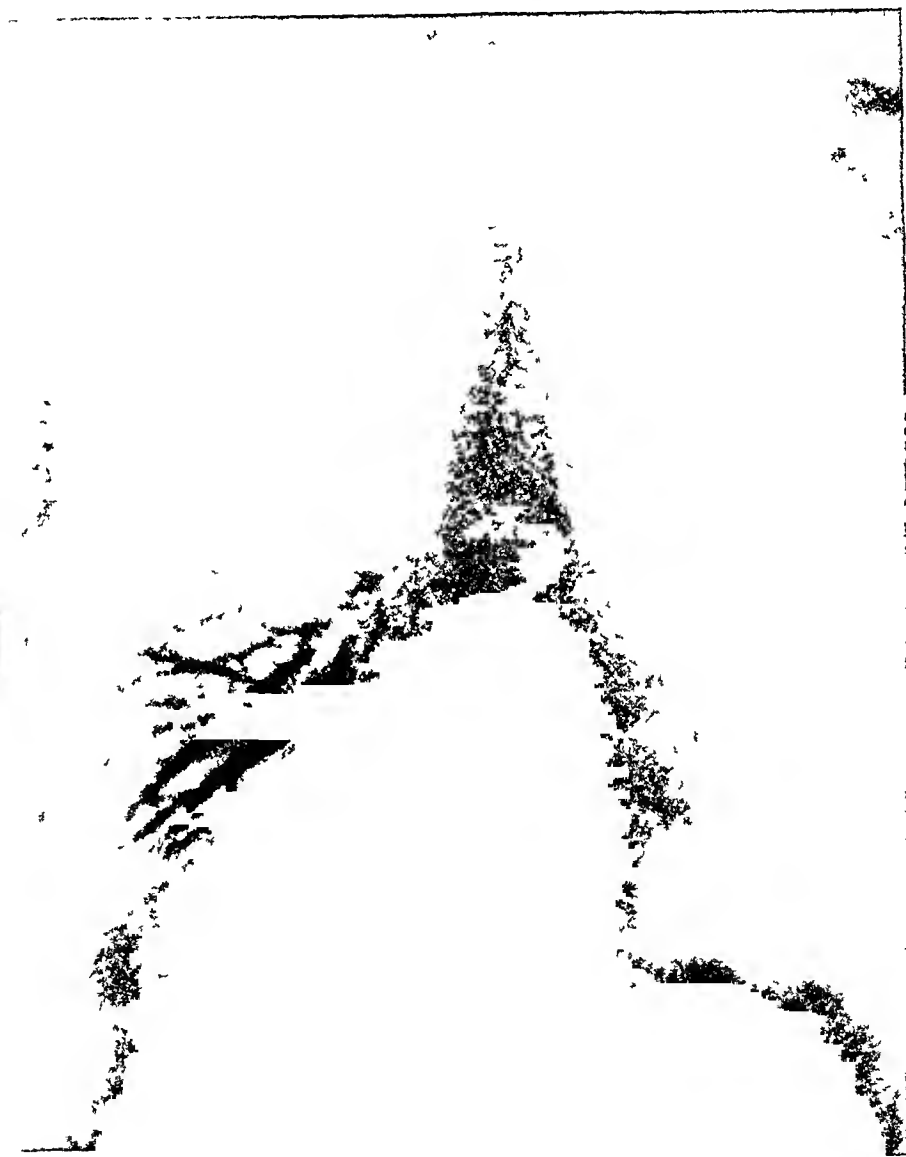


FIG. 3.—Roentgenogram after the injection of lipiodol of boy aged seventeen years who for three years had had the classical syndrome of bronchiectasis raising six to eight ounces of purulent sputum each twenty-four hours.

may, however, be entirely overlooked. Two of our patients had cough and sputum persistent after drainage of what seemed simple abscesses and subsequent examination after lipiodol injection showed in each a complicating bronchiectasis. Ballon⁶ has already noted the frequent incidence of bronchiectasis with abscess.

In many cases of abscess a diffuse fibrosis or pleural thickening mask

both the physical and the X-ray findings. In other cases for which the term suppurative pneumonia is perhaps the most descriptive term, the lesion is definitely localizable, but at operation the whole diseased portion of the lung is found to be honey-combed with multiple small abscesses. The lipiodol roentgenogram is about the only means of differentiating these cases. In the first mentioned group drainage is in-

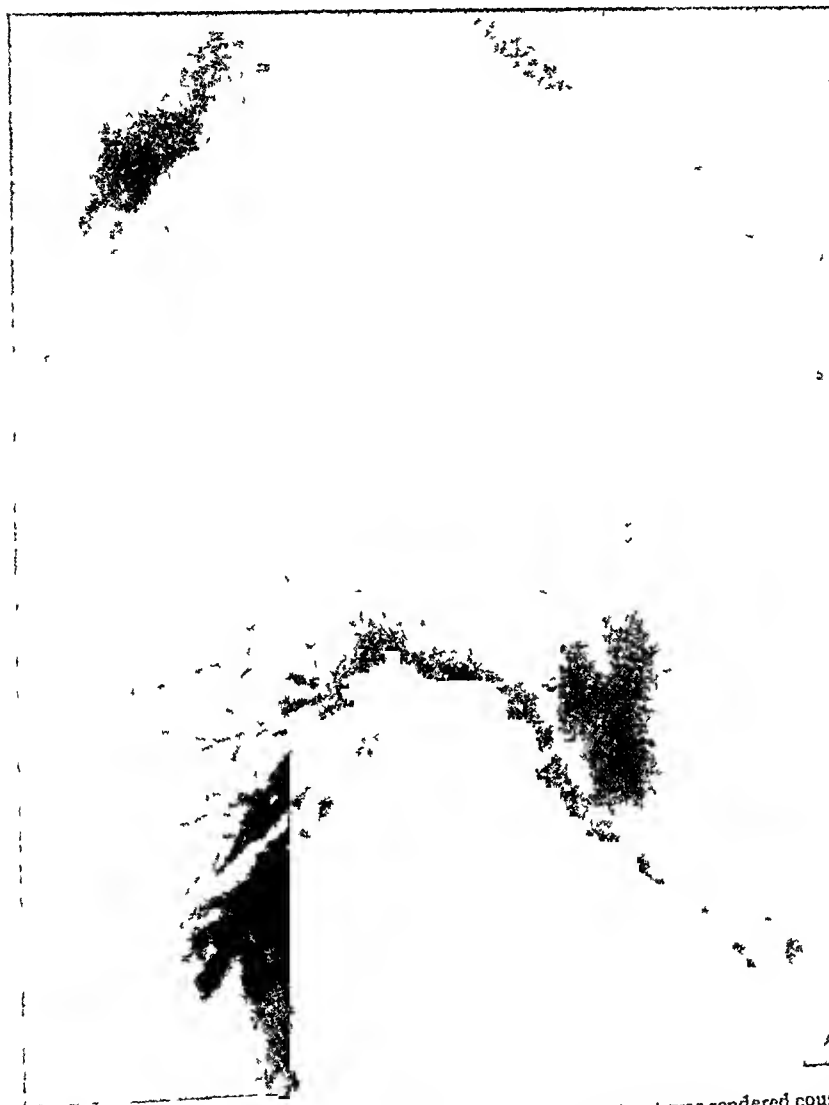


FIG. 4.—Roentgenogram of same patient as Fig. 3. This patient was rendered cough and sputum free by avulsion of the right phrenic nerve.

dedicated, in the latter cauterization. Ballon has noted that unless care is taken to empty the abscess by posture before the injection, the oil will often not flow into it and the plates will merely show a bronchus ending blindly. He explains this on the basis that in the abscess the emptying is by overflow, not by active expulsion as in bronchiectasis. In some cases bronchoscopic aspiration is probably necessary for evacuation of the pus. The lipiodol can then be instilled through the bronchoscope.

Empyema—There is no way of determining accurately the size and location of a single empyema cavity and the presence of multiple communicating

cavities except by rontgenogram after the injection of a contrast medium. We have used 12 per cent sodium iodide solution. It is irritating, however, to the bronchial mucous membrane and so cannot be used when a fistula is present. When a bronchial fistula was suspected, we have injected a dye into the cavity and by recovering some of it in the sputum verified its presence, but it has been impossible to outline the cavity, locate the fistula or determine its size. In these cases lipiodol is of very great value, affording information on all of these points.

Fistulae of Chest Wall—Not infrequently one encounters cases where the complaint and the most obvious physical finding is a sinus in the chest wall. The sinus may be due to empyema, a narrow pleuro-cutaneous sinus, bronchocutaneous fistula, or osteomyelitis of a rib. Heretofore we investigated these, first by injecting a dye, then, if no bronchial fistula was found, by injecting sodium iodide or bismuth in oil. If lipiodol is injected instead the nature and extent of the sinus may be demonstrated by the rontgenogram without any danger of un-



FIG 5—Rontgenogram after the injection of lipiodol of girl aged nine years, who for three years had had the classical symptoms of bronchiectasis. The plain plate showed no pathology save slight peribronchial infiltration.

toward results from bronchial irrigation, or, in case bismuth is used from its absorption or from the possibility of fatal cerebral manifestations.

Pulmonary Tuberculosis—There has been considerable discussion concerning the possible harmfulness of injecting lipiodol into the bronchi in pulmonary tuberculosis. Many have hesitated to use it because of the long-established belief that iodine breaks down the encapsulating fibrous tissue

and activates the tuberculous process. It seems generally agreed that the soft rapidly progressive types of the disease are made worse by iodine. Whether or not the method is entirely harmless in the more fibroid type remains to be determined. We have used it in three instances where the

information to be derived from it seemed especially desirable.

In most cases of pulmonary tuberculosis in which surgical treatment is considered, the added information which one might gain from lipiodol plates would ordinarily have but little significance. In these cases the question is as to whether or not pulmo-



FIG 6 —Multiple empyema cavities. Röntgenogram taken after the injection of lipiodol into a draining sinus in the chest wall.

nary collapse is indicated and if the other lung is sound one would ordinarily proceed with the operation regardless of the extent of the cavities in the lung involved. The method may possibly be of some value in some cases in demonstrating the nature and extent of a lesion in the better lung and so aid in the selection of cases for operation.

Intra-thoracic Neoplasms—We have used lipiodol in one case of intra-thoracic neoplasm. The ordinary röntgenogram showed a sharply outlined tumor extending into the lung field from the hilus region. The problem was whether or not the growth invaded the pulmonary tissue and what its relation to the bronchus might be. The plate furnished definite information on these points.

In Estimating the Results of Operation—It has already been stated that the method is valuable in judging the results of drainage, cautery, and collapse operations. It enables one to determine between several stage operations, for abscess and for bronchiectasis, just how much has already been accomplished and what further is indicated. Ordinary iongenographic findings after operation are usually so abnormal and obscured by pleural

thickening that they afford little information. The physical signs are similarly masked, and the chief symptom the amount of sputum, is often misleading. After cauterization it is difficult to determine the amount of pus evacuated because of an associated profuse watery bronchorrhoea. In bronchiect-



FIG 7—Röntgenogram after the injection of lipiodol, of patient who had persistent cough and sputum after external drainage of a lung abscess. The plates showed nothing to indicate the cause. Note the residual bronchiectasis in the region of the healed abscess.

tasis there may be a reduction in the sputum out of proportion to the degree of collapse of the cavities. We have had several cases in which the improvement immediately after the operation was much greater than that which became permanent. In these cases subsequent lipiodol plates showed considerable cavities still uncollapsed.

Certain aspects of the subject merit discussion. These are in the order of their importance, (1) the question of its innocuousness, (2) the interpretation of the plates, and (3) the method of making the injection.

The Question of Possible Harmful Effects from Lipiodol—(1) On first consideration the introduction of so large an amount of foreign substance into the finer ramifications of the bronchial tree seems a radical procedure. One might anticipate a severe immediate reaction, or that later complications in the nature of abscess, bronchiectasis or fibrosis might result. At present

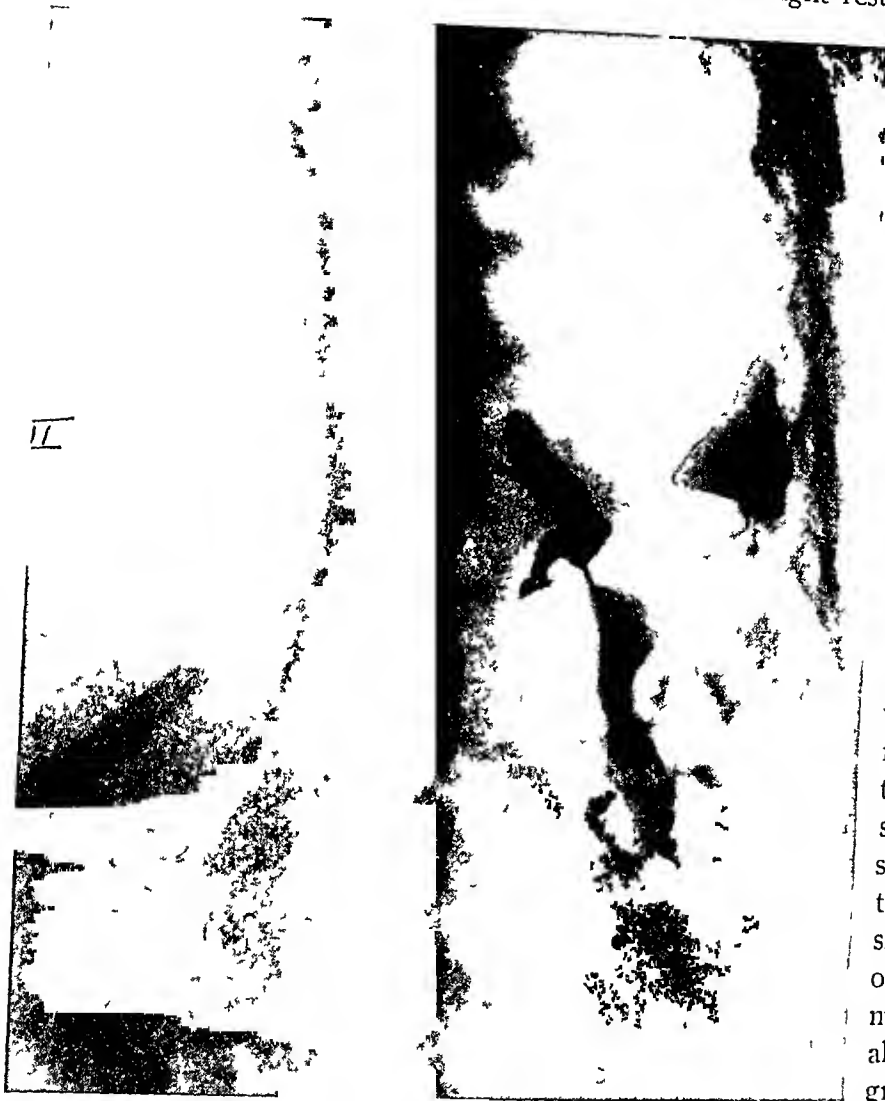


FIG 8—Multiple empyema cavities. Rontgenogram taken after the injection of lipiodol into a draining sinus in the chest wall.

all that can be said is that so far none have been observed. The patients do not cough during the injection. In the course of ten or fifteen minutes they have what is for most of them a normal coughing spell during which they raise most of the oil. This spell is not severe or protracted. A small amount of the oil remains in the alveoli and is gradually absorbed over the course of

weeks or months. We have had patients in case of whom this oil had disappeared entirely in a week, in others it was still present in part after several months. It is expelled from abnormal pulmonary cavities more readily than from the terminal bronchi of the normal lung.

We have not used the oil in a patient who did not have a cough before the injection. In those patients in case of whom we have used it, and we have often injected large areas of normal lung, the preexistent cough has either lessened or remained unchanged. In none have we been able to note any ill effects. At the present time we have under observation a series of

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dogs in whom we have made injections. These will be autopsied at intervals and the lungs examined grossly and microscopically.

Interpretation of Rontgenograms—(2) As yet but little can be said on the interpretation of the plates. In many of them the findings are definite, but it is probable that interpretation is not as simple as it may seem. Sargent has noted sacculations in emphysema which are with difficulty distinguished from those in

bronchiectasis. Ballou has called attention to the occasional failure of filling of an abscess. There is always the chance that the oil will not flow into the affected area. One factor which will always have to be considered is the fact that the picture varies with the amount of oil injected. If the patient coughs before the exposure there results a rather characteristic picture.

Compared with the normal it is much

as if one had brushed his hand across a finely drawn etching while it was still wet—often such pictures are entirely unintelligible.

Methods of Making the Injection—There are four methods of making the injections—the supraglottic, the transglottic, the subglottic, and the bronchoscopic. In the first the pharynx and base of the tongue are anesthetized, the tongue pulled forward and the oil dropped over the base of it as the patient inspires.



FIG 9.—Unilateral pulmonary tuberculosis. Repeated hæmoptysis. Extra-pleural thoracoplasty. The patient was greatly improved by thoracoplasty, but still had an occasional hæmoptysis. Röntgenogram taken after the injection of lipiodol. There is stenosis of the right main bronchus. Since this picture was taken a pneumolysis has been performed following which the hemorrhages have practically ceased.

In the transglottic method, after careful cocainization of the pharynx and larynx, the oil is injected through a curved cannula which, under direction of the laryngoscopic mirror, is inserted between the vocal cords. This requires special training on the part of the operator and considerable cooperation from the patient. It cannot be used in children.

The injection of the oil through the bronchoscope requires no explanation.

We have had experience only with the subglottic method. In this a curved cannula is inserted through the crico-thyroid membrane and the oil injected directly into the trachea. The instruments and technique were developed by Rosenthal⁸ for tracheal medication and were later adopted for the present purpose by Forestier, Sergent⁹ and Armand-Dehille¹⁰. The instruments here described were modelled after these and were made by V. Mueller and Co. They consist of a 30-c.c. Record syringe (a) fitted with a threaded piston stem, a two-inch connection of catheter rubber (b) with adapters, and a curved tracheal trocar and cannula (c). The



FIG. 10.—Pulmonary tuberculosis, apical pneumothorax with bronchial fistula. Röntgenograms taken after the injection of lipiodol.

screw mechanism is necessary because the oil, being relatively viscid, is with difficulty forced out by direct pressure. The catheter connecting piece permits movement of the cannula on swallowing or coughing without movement of the syringe. The curved cannula (Armand-Dehille¹⁰) is used rather than a straight or curved needle (Sergent and Cottenot⁹), because it is less likely to injure the posterior tracheal wall and is better tolerated than a sharp instrument. The cannula is made in two sizes, one for children and the other for adults.

The technique of the procedure is as follows:

LIPIODAL IN RELATION TO THORACIC SURGERY

One hour before the injection to control the cough reflex the patient is given from $\frac{1}{2}$ to 1 grain of codeine hypodermically. About three-quarters of an hour later he is directed to bend over and rid himself of all accumulated sputum. He is then seated in a chair facing the operator, his neck painted with iodine and with a fine hypodermic needle and 3 per cent novocaine a dermal wheal is raised in the midline just above the cricoid. The infiltration is then carried to the level of the trachea and with a slightly larger needle the trachea punctured and 4 to 5 cc of the 3 per cent novocaine solution injected. This usually causes coughing and it may be necessary to draw out the needle and re-insert it two or three times before the whole amount is instilled. While the novocaine is taking effect a tiny incision is made just through the skin with a narrow-bladed knife, and the lipiodol, which has been placed in a basin of warm water to bring it to the body temperature and decrease its viscosity, is poured into the syringe. Then, with the forefinger of the left hand acting as a guide on the cricoid, the trocar and cannula are inserted through the skin incision and into the trachea. The trocar is removed and with an assistant steadying the cannula the syringe is fitted to it and the injection made. Before starting it the patient is told that coughing will spoil the result and is asked to try very hard not to cough.

The position of the patient during the injection is very important. Gravity determines the portion of the bronchial tree into which the lipiodol flows. With the patient upright, most of the oil will go into the left lower bronchus. This cannot be counted upon, however. In case one wishes to inject the left lower bronchus the body should be inclined to the left at an angle of about 30 degrees. If it is desired to inject the right lower bronchus, the inclination should be to the right side. Both lower lobes can be filled by injecting part of the oil while the patient is leaning to the right, the remainder while he is leaning to the left. To fill the middle lobe the injection is made with the patient recumbent upon the affected side. Examination of an apex is the most difficult. In some instances one can be filled with the patient in the recumbent lateral position. It can be reached more certainly if immediately after the injection of the oil the patient is held over the edge of the table in the lateral position and with the head slightly lower than the hips.

The amount of oil injected is usually 20 cc. Forestier mentions having administered as much as 60 cc at one time. What the maximum amount of lipiodal that may be injected with safety at one time may be remains to be determined. Not infrequently one is able to outline the bronchial tree of one lobe with injection of no more than 20 to 30 cc and without producing symptoms.

The X-rays must be taken immediately after the injection. While usually the patient does not begin to cough for 10 to 15 minutes there is always danger that he may do so and consequently the sooner the picture can be taken the less are the chances of failure from this source. It is our custom to take stereoscopic plates of the chest and then one oblique plate. The

oblique position often throws into relief shadows which are otherwise obscured by the heart or diaphragm

BIBLIOGRAPHY

- ¹ Beck, E. G. *Fistulous Tracts, Tuberculous Sinuses, and Abscess Cavities. A New Method of Diagnosis and Treatment by Bismuth Paste*. J. A. M. A., 1908, vol. 1, p. 867
- ² Jackson, Chevalier. *The Bronchial Tree. Its Study by Insufflation of Opaque Substances in the Living*. Am. J. of Roentg., 1918, vol. v, p. 454
- ³ Lynah. *Lung Mapping by Injection of Bismuth Mixtures in the Living*. New York Med. J., 1921, vol. cxiv, p. 82
- ⁴ Sicard, and Forestier, J. *Iodized Oil as Contrast Medium in Radioscopy*, Bull. et mem. Soc. med. d. hop. de Paris, 1922, vol. xlv, p. 463
- ⁵ Bezancon. *The Dry Hæmoptysic Type of Bronchiectasis*. Bull. Acad. d. Med. de Paris, 1924, vol. xci, p. 100
- ⁶ Ballou, D. H. *Lipiodol in the Diagnosis of Broncho-pulmonary Lesions by Bronchoscopic Method*. Arch. Otolaryngol., 1926, vol. iii, p. 403
- ⁷ Forestier, J., Sicard, J. A., and Fabre. *Elimination of Iodine in the Urine*. Bull. et mem. Soc. med. d. hop. de Paris, 1923, vol. xlvii, p. 315
- ⁸ Rosenthal, G. *The Technic of Intercrico-thyroid Injections*. Paris Med., 1920, vol. x, p. 521
- ⁹ Sergent, E., and Cottenot, P. Cited by Armand-Delille¹⁰
- ¹⁰ Armand-Delille, Duhamel et Marty. *Iodized Oil in Roentgen Diagnosis of Bronchiectasis*. Presse Medical, 1924, vol. xxxii, p. 421

OBSERVATIONS ON PEPTIC ULCER

I A METHOD OF PRODUCING CHRONIC GASTRIC ULCER

A CONSIDERATION OF ETIOLOGY

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ULCERS produced in the stomachs of dogs by the methods herein described have in general the same characteristics as the peptic ulcer found in the stomach and duodenum of man, they are subacute or chronic, show little or no tendency to heal, and are inclined to perforate. They also appear to have a selective affinity for the parts of the stomach that are shown clinically to harbor peptic ulcers most frequently. It would seem, therefore, that the data obtained from the experimental study of such ulcer might throw some light on the etiology.

As a background for such a study, the literature was reviewed, particular attention being paid to the experimental production of ulcers and its relation to the etiology of the disease. So much has been written, however, concerning these two phases of the problem that it is impossible in one paper to do more than outline the work that has been accomplished. Bolton, Gregg, Ivy, Butsch, Durante, Rosenow and others have reviewed the literature comprehensively. I shall refer the reader to their work for many historical points too detailed to be considered here.

While ulcer was apparently recognized as long ago as the time of Celsus, and an undoubted case, described by Johann Bauhin in the sixteenth century, was cited by Lebert in 1878 the postmortem appearances and clinical manifestations of the disease were first accurately described by Mathew Baillie in 1818. To Cruveilhier, however, writing a few years later, belongs the credit of having first thoroughly investigated the subject and described in detail the morbid appearances, complications and sequelae, clinical history, and rational treatment of the disease.

It was in 1853 that Virchow advanced his hypothesis that the origin of ulcer lay in circulatory changes, since then it has been the subject of much clinical and experimental study. Numerous other hypotheses have been advanced but their very multiplicity demonstrates that there must be several etiologic factors in the production of ulcer no one of which can be exclusively incriminated.

The importance of peptic ulcer to-day, not only as a problem in treatment which confronts the physician and surgeon, but also as an economic problem is made more apparent by the evidence of statistics. Brinton in 1864 found that gastric ulcer was present in 5 per cent of all necropsy subjects. Tenwick in 1900 stated from an analysis of 825 cases that ulcer of the stomach was found oftenest in the third and fifth decades of life. Bolton from a com-

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parison of several groups of statistics, concluded that females were more susceptible to ulcer than males. W. J. Mayo, however, in 1911, from statistics of 1000 at operation, found ulcer of the stomach or duodenum or both in 255 women and 745 men. More recent statistics by Robertson and Hargis, from an analysis of 2000 necropsy reports, showed an occurrence of ulcer or scars of ulcer totalling 18.9 per cent. Of these, 7.05 per cent were gastric, 11.85 per cent were duodenal, and 7 per cent affected both stomach and duodenum. In this series the ratio of males to females was three to one, verifying the operation statistics of W. J. Mayo.

Ulcer then is a relatively common disease, is apparently on the increase, and is encountered most frequently in the most active and productive period of life. It is very important to distinguish between the acute and chronic types or stages. They are so different in characteristics and properties that it may be well to compare them briefly.

An acute ulcer, or an ulcer in the acute stage, has grossly a definitely acute and fresh appearance. It gives the impression of an area having been dissolved out rapidly and cleanly, leaving usually a funnel-shaped depression of variable size, depending on the agent that has produced the lesion. The shape also is variable, depending on the mode of production, although most of the lesions are roughly circular or elliptical. Microscopically the ulcer is sharply defined, the tissue surrounding the acute lesion being, for the most part, healthy and normal. The epithelium at the edge is healthy looking and, almost as soon as the erosive process that caused the acute ulcer has ceased to act, the epithelial cells begin to grow out and repair the gap in the mucosa. The acute lesion tends to heal rapidly, and everywhere evidences of this tendency are present.

A chronic ulcer has a very different appearance. It has a sluggish chronic look, the base is dirty, necrotic, and indurated. The edges are thick and raised and tend, like the edges of a bank that has been undermined by the gnawing of a swift current, to overhang. The surrounding mucosa usually shows chronic inflammation of varying degrees that is covered with thick and tenacious mucus. Size and shape are variable, although the medium-sized, punched-out, circular or elliptical lesion is the rule. Microscopically the ulcer is equally characteristic. The crater is often cone-shaped with the apex toward the mucosal surface, the mucosa is overhanging and stops abruptly. Signs of epithelial proliferation at the edge, if present at all, are meagre and limited. The submucosa is definitely, sometimes markedly thickened, having in section the shape of a wedge with the thick part pointing toward the crater and the point gradually tapering off and losing itself in the normal submucosa distal to the ulcer. There is marked cellular infiltration of the surrounding tissue, with necrosis of that immediately adjacent to the crater. The depth of the ulcer is variable and the base may even be formed by another organ if the ulcer has eroded entirely through the gastric wall. The chronic lesion not only shows absence of healing characteristics, but often shows evidence of a slow process of extension.

These are the two extremes of acute and chronic lesions, but in between are lesions that exhibit, more or less, the characteristics of both. They are the subacute ulcer which probably represents the transition from the acute to the chronic lesion. Most observers agree fairly well that chronic peptic ulcer very probably has its origin in an acute ulcer. Bolton's hypothesis is that some unknown factor initially damages the cells of the gastric mucosa and so reduces the normal powers of resistance that autodigestion then takes place, giving rise to an acute ulcer. He believes that the chronicity is dependent on some secondary factor, such as infection of the crater and margins.

Acute ulcer of the stomach occurs not only spontaneously in certain conditions (for the most part the acute infections, fevers and toxæmias), but can be produced experimentally in many ways. Butsch, Greggio and Bolton have described the methods in more or less detail and have included the references to original papers. Greggio has grouped the methods of producing ulcers as follows:

1. Certain drugs, poisons, irritants and toxins by general or local injection or by ingestion, the excision of certain special organs—the adrenals, thyroid, liver and so forth.

2. Changes in the blood supply of the stomach caused by injecting emboli, coagulants and so forth into the local or general circulation, by ligating certain vessels or groups of vessels, or by producing retrograde emboli or thrombi by ligating or injuring vessels or groups of vessels having to do with gastric circulation.

3. Changes in the composition of the blood brought about by the administration of pyrogallic acid, pyrodim and so forth to produce anæmia, and often combined with trauma to the gastric wall or its nerve supply.

4. Autodigestion caused by isolation of gastric pouches by certain methods, autodigestion caused by experimental pyloric stenosis, hyperchlorhydria, pyloric insufficiency with reflux of pancreatic juice, and other means of reducing the acids of the stomach. Injection of mucosal extracts, or local injury, together with section of nerves or ligation of vessels.

5. Local trauma to gastric mucosa by ingestion of foreign bodies or by caustics, cold or heat, mechanical injury, excision of mucosa and so forth, combined with various other procedures such as ligation of vessels, local infection of traumatized area, ingestion of hydrochloric acid to produce hyperchlorhydria, injections to destroy antipepsin, suture of rings to gastric wall around traumatized area to prevent shrinkage of the lesion by muscular contraction.

6. Infection by injecting into the local or general circulation or into the peritoneum bacteria of various sorts or their toxins, or in some cases by administering these bacteria by mouth, use of local trauma to the mucosa or injury, interference with the nerve supply or blood supply in conjunction with these means of infection.

7. Injury or section of tracts in the central or peripheral nervous system to upset the nervous mechanism controlling the stomach and the function of

other digestive glands and organs, nerve injury combined with infection, trauma, circulatory changes, experimental anæmia, and other methods

8 Local injections of adrenalin, formalin, gastrotoxin, silver nitrate, chloral, neurin or cold or hot solutions into the gastric wall or vessels

Many modifications and combinations of methods have been used, almost any of which have produced some type of acute lesion, varying from small hemorrhages into the mucosa to extensive erosions involving a large part of the stomach

The means of inducing chronic ulcer in animals experimentally are as few as those of inducing acute ulcer are numerous. Mann goes so far as to say that chronic peptic ulcers appear to have never been consistently produced experimentally in the gastric mucosa by any method

Acute ulcers, which under normal conditions and in spite of most experimental conditions heal readily, have in some cases been retarded in healing. A few investigators have been able to induce lesions in the stomach or duodenum of animals that are similar, in some respects, to the chronic peptic ulcer found in the stomach and duodenum of man. Bolton and Friedman and Hamberger, by producing partial pyloric stenosis operatively, caused a delay in the healing of acute ulcers induced by gastrotoxin. Ivy was able, in gastric pouches of pyloric mucosa, to cause delay in healing of acute ulcers by frequently rubbing their surface with cotton and bread crumbs. Turk produced a few perforating ulcers of the stomach by feeding cultures of *bacillus coli*, but these ulcers were more acute than chronic.

Greggio by section of the vagi induced gastric ulcers in a few instances which had some characteristics of chronicity. Vedova and Durante produced so-called chronic and acute ulcers in the stomach by resection of the splanchnic nerves. Durante asserted that the integrity of the sympathetic nervous system, controlling as it does circulation, secretion and profound sensibility of the stomach, is necessary to the life of the gastric cell. Recently Bedarida by injecting neurin, a specific paralyzer of motor nerve terminals and the sensory secretory plexus in the submucosa, obtained neurotrophic ulcers in the stomachs of rabbits.

Ivy in a few cases found ulcers after gastroduodenostomy but thought they were due to the malnutrition of the animal after operation. Dott and Lim, by gastro-enterostomy and pyloric exclusion, and Exalto, by a modified "Y" operation, produced chronic types of ulcer in the jejunum. Kehrer reported that apparent subacute gastric and duodenal ulcers had been induced in dogs in some instances by the diversion of the bile and pancreatic juices into the ileum.

Dragstedt and Vaughan, after producing acute ulcers in the stomach by injecting silver nitrate into the mucosa and then putting loops of non-absorbable suture material in the gastric wall at the points of injury, were able to make the ulcers persist for three or four months and assume some characteristics of chronicity.

Rosenow, by the intravenous injection of streptococci with specific powers

of localization, produced ulcers in the stomach and duodenum of animals that in some respects resemble the ulcers found in the stomach and duodenum of man. Recently Hoffman has produced similar lesions by the use of a similar technic, although his organisms were short bacilli.

Mann and Williamson produced ulcers in the duodenum and jejunum of dogs by shunting the alkaline secretions into the lower ileum where they could not serve to neutralize the gastric juice. The ulcers produced in this manner occurred in more than 90 per cent of experiments, and are probably more like the clinical peptic ulcer than any experimental lesion which has yet been produced.

Since it is so difficult to produce experimentally in the stomach an ulcer that does not heal, a short consideration of the healing process seems not amiss. Pavy, Ziemssen, Leube, Cramer, Quincke and Daettwyler, Cohnheim, Griffin and Vassale, Matthes, Bolton, Ivy, Mann, and others have studied the healing of ulcers. Ivy divided the process into two stages: the first tended to lessen mechanically the area to be covered by mucosa and to prepare the field for healing; the second, characterized by the actual covering of the crater with epithelium and the growth of the glands, gave the area a true mucosal covering.

More recently Mann has studied the healing process in detail from a large number of ulcers produced by this method of "surgical duodenal drainage." He has observed that the base of the lesion is first cleaned, slough separates and a protecting coat of serum and coagulum forms over healthy granulations. These processes ordinarily take about four days. Simultaneously the mucosa begins to grow out from the edges as a thin layer of flat epithelial cells. The edges of the mucosa tend to overhang and the granulations to push up in the centre so that the growing edge of mucosa is protected in the resulting depression. This initial stage, which has the effect of also decreasing the area to be healed over, takes place in about ten days. Once initiated, the healing, if undisturbed, is rapid. In twenty days three-fourths or more of the base is covered with epithelium, and in thirty days the lesion is usually healed entirely. The scarring is in many cases hardly noticeable.

Recently Kennedy and Caylor in clinical duodenal and gastric ulcers, respectively, have found healing lesions that correspond strikingly to the healing process in experimental peptic ulcers as described by Mann.

But, as Bolton points out, any agent which retards this healing process causes scarring, thickening, and induration of the base and gives the ulcer a punched-out appearance. The submucosa tends to thicken, approaching the wedge-like form seen in chronic ulcers.

Although a few investigators have been able to cause delay in healing of acute ulcers and others have been able to produce experimentally, ulcers that have some characteristics of chronicity, the problem of the etiology of peptic ulcer is still on rather a hypothetical basis. It has been the subject of many hypotheses since the time when Virchow, in 1853, suggested that ulcer was

probably due to obstruction of the circulation by thrombotic plugs in the vessels. It has since been shown that the thrombi are probably secondary to, and arise from, the infected ulcer. Many observers have tried in various ways to interfere with the circulation of the stomach or parts of it, but ulcers have been produced only when the very terminal vessels have been plugged. Furthermore, such ulcers do not manifest the characteristics of the chronic peptic ulcer.

The numerous other theories advanced to explain peptic ulcer have been grouped by Gieglio and may be outlined as follows:

1 Local changes in the gastric mucosa caused by irritants such as alcohol, drugs and so forth, gastritis, lesions resulting from acute catarrhal processes, and from disturbed digestion.

2 Circulatory lesions of the gastric wall as a result of thrombosis, embolism, hemorrhagic infarct, stasis, ischæmia, injury to vasolymphatics, vascular spasm, reflex or nervous spasm or anatomic anomalies of arteries or their distribution.

3 Alterations in the composition of the blood as found in such conditions as chlorosis, anæmia, hæmoglobinæmia, decreased alkalinity of the blood, changes in the local or general antipepsin content of the blood, hemorrhagic diathesis from functional disease of the liver, and changes in the blood as a result of skin burns.

4 Autodigestion as the result of gastric stasis, changes in acid-pepsin secretion, changes in blood supply or nerve supply of the mucosa, lack of anti-pepsin, changes in the composition of the blood, inflammation of underlying lymph follicles, or islands of intestinal mucosal cells in the gastric mucosa.

5 Trauma from ingestion of foreign bodies, blows on the epigastrium, long-continued pressure over the epigastrium from tight clothing and so forth, and pressure of tumors.

6 Infection such as that resulting from septic emboli, from infection in the blood in local or general septic processes, from local infection of the mucosa by ingested bacteria or their toxins.

7 Disturbance of the nervous control of the stomach causing a neurotrophic lesion or one that is due to the resultant changes in secretory, sensory-motor, and vasomotor functions of the stomach.

8 Certain constitutional diseases, such as certain of the blood dyscrasias, sepsis, tuberculosis, dysfunctions of endocrine gland and so forth.

While these theories may explain certain individual cases of ulcer, they do not solve the real problem, the chronicity of peptic ulcer.

METHOD OF EXPERIMENTATION

In the study of experimental ulcer two facts seemed to stand out. First, all acute lesions produced in the normal stomach healed very readily, and second, the method of surgical duodenal drainage described by Mann and Williamson produced ulcers in the jejunum in almost 100 per cent of experi-

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ments I then conceived the idea of making acute lesions in the stomach and in addition performing surgical duodenal drainage in order to determine whether the stomach would still heal with its usual ease. Dogs were used in all experiments and for the operative procedures ether anaesthesia and aseptic technic were employed.

No rubber-covered or other intestinal clamps, and no unabsorbable sutures were used in any of the operations, all of which were performed by me.

The stomach was opened anteriorly by means of a small incision. In selected portions of the stomach four areas of mucosa, caught and lifted up with Allis forceps, were excised with sharp scissors. In this procedure the mucosa and part of the submucosa (and in some experiments the greater part of the muscularis) were excised cleanly, thus four circular areas about 2 cm in diameter were denuded of mucosa. The excised areas were situated as follows. The first and second were on the lesser and greater curvatures, respectively, about 2 or 3 cm from the pylorus, the third was midway along the lesser curvature and the fourth midway along the greater curvature (Fig 1). Hemorrhage was sometimes profuse for a few moments, but always stopped spontaneously. In no case was any suture or ligature applied to vessels in these areas and no case of secondary hemorrhage was encountered. In a few cases similar lesions were made in the duodenum.

After the incision in the stomach had been closed, the operation for surgical duodenal drainage was performed in certain cases as described by Mann and Williamson. Briefly, this consisted in severing the pylorus and closing the distal end, severing the first part of the jejunum, closing the

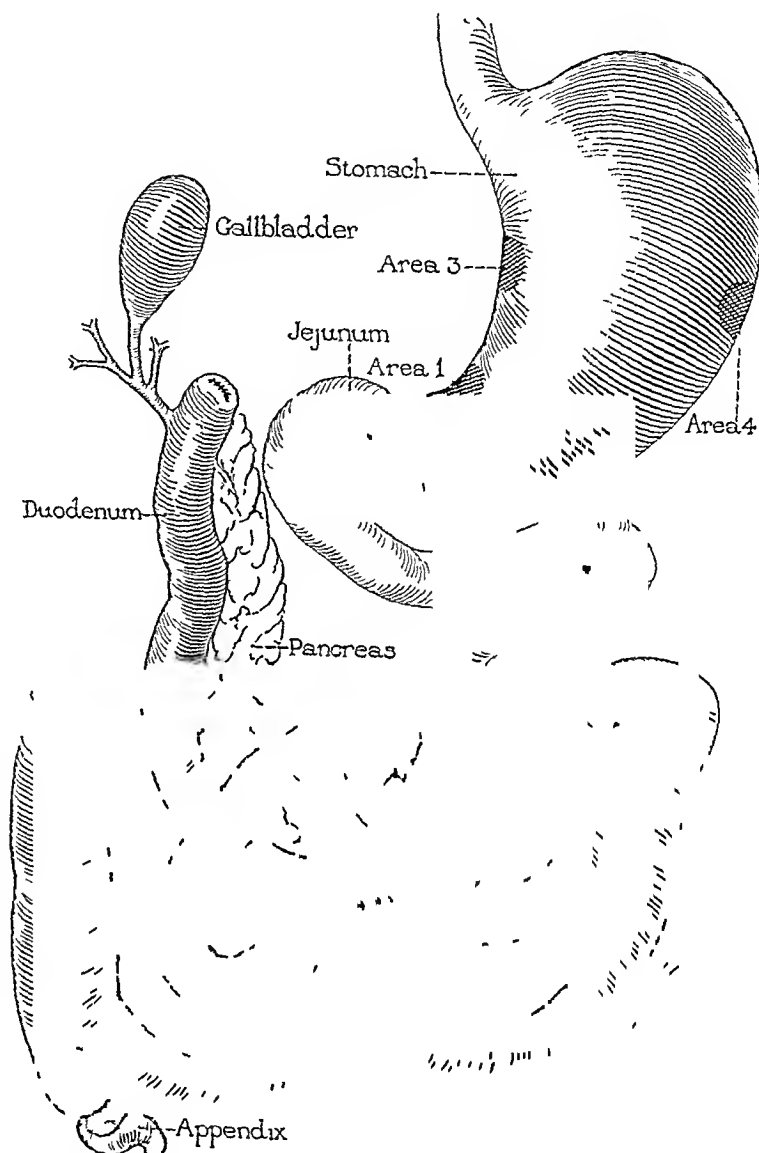


FIG 1.—Diagram of operative procedures. Stomach shows areas of mucosa excised in experiments of Group 1. Gastro-intestinal tract shows method of surgical duodenal drainage in Group 2. Diagram, as a whole, shows the entire operative procedures in Groups 3 and 4.

proximal portion of it, and suturing the distal portion to the cut end of pylorus by end-to-end anastomosis. By this arrangement the place of the duodenum was taken by the jejunum, and the duodenum, together with a small portion of the adjacent upper jejunum, was left as a closed segment of gut. To provide this an outlet the distal end was drained into the ileum by side-to-side anastomosis. It was found most satisfactory to make this anastomosis between 25 and 50 cm from the cæcum (Fig 1). Following this the omentum was used to cover the sites of anastomosis and the abdomen was closed.

The operative technic was soon mastered and proved very satisfactory in that the procedures could be quickly carried out and practically all the animals survived the operation.

The duodenum had thus been anatomically replaced by the first portion of the jejunum. The duodenum had been drained, however, into the ileum at a point which, although too distant from the stomach to permit of the possibility of regurgitation of its alkaline contents into the pyloric region, nevertheless permitted the duodenal secretions, mixed with bile and pancreatic juice, to carry out to some extent their essential part in the digestive process. The first portion of the jejunum, having been anastomosed to the stomach, now occupied the position normally occupied by the duodenum. There were four areas unprotected by mucosa on the internal surface of the stomach. The pylorus had been severed and the duodenum moved, so that not only had the emptying mechanism at the pylorus been upset, but the presence and regurgitation of alkaline secretions into the stomach had been precluded.

Following operation the animals were given the usual care. Food consisted of a regular mixed diet with the addition of milk and syrup. It has been found that milk and syrup, because of their easy assimilability, aid materially in keeping up the animal's state of nutrition. As a rule the nutrition was maintained fairly well up to the time when jejunal or gastric ulcer or both appeared and became definitely chronic.

The experiments were divided into four groups, the first two serving as controls on the others. In the first group areas of mucosa, or in some cases both mucosa and muscularis, were excised from the normal stomach or duodenum and the continuity of the gastro-intestinal tract left intact. In the second group the stomach was undisturbed and the operation for surgical duodenal drainage was performed. In the third group areas of gastric mucosa were excised and at the same time the operation for surgical duodenal drainage was performed. In the fourth group the operation for surgical duodenal drainage was performed and after an interval of two weeks the usual four areas of gastric mucosa were excised.

RESULTS

Group 1—In this group (simple excision of gastric or duodenal mucosa) there were eight experiments. The lesions made at operation were examined at intervals of from eight to fifteen days, either after the animal had been

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killed under anæsthesia or the portion of the tract containing the lesions had been resected. In all cases the lesions which had been made at operation healed quickly and readily. This was true of both the suture line in the anterior wall of the stomach and four areas which had been denuded of mucosa. It was especially noted that very soon after the lesion had been produced the muscular contraction of the gastric wall in that zone produced

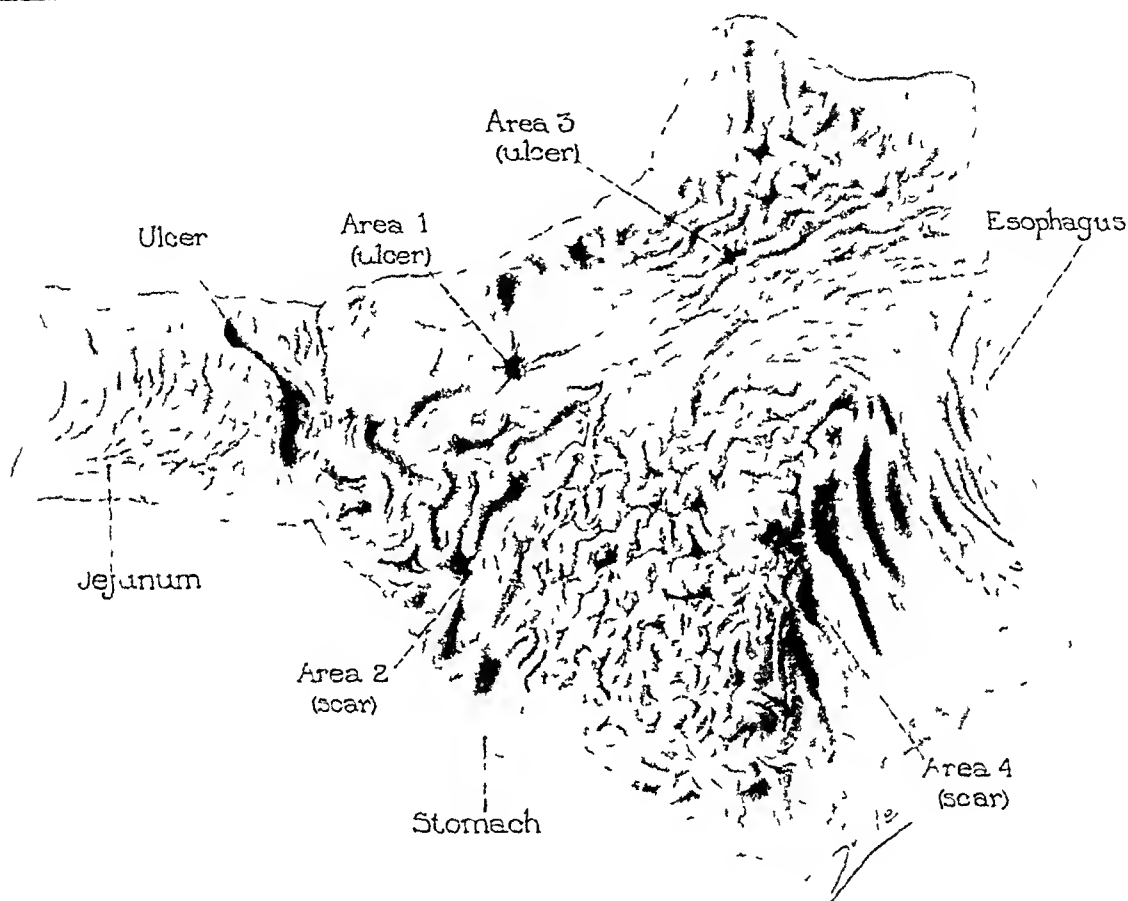


FIG. 2.—Drawing of stomach and jejunum showing typical sites of all lesions described in the experiments. Stomach one month after final operation in Group 4. Typical ulcer, chronic type, at area 1 on lesser curvature. Smaller ulcer at area 3. Areas 2 and 4 on greater curvature healed.

marked shrinkage in the size of the denuded area, sometimes leaving it only a half or a third the original size.

The areas on the lesser curvature and near the pylorus, judging by the relative sizes of the lesions at various intervals, seemed to heal a trifle more slowly than those in the fundic region and on the greater curvature. All, however, were entirely healed over with great rapidity, two weeks being apparently sufficient for an epithelial covering to form over the entire area denuded at operation. The only evidence of the original lesions was a very faintly outlined mucosal puckering and scarring more closely attached to the deeper layers of the gastric wall than the surrounding mucosa. Persistent and careful search was often necessary to find these tiny scarred areas.

In the animals in which both mucosa and muscularis were excised, the healing seemed to take place with almost as great ease and rapidity as when

only the mucosa had been excised, even when the underlying tissue had been so thoroughly excised that only the sheerest layer of serosa was left to form the base of the lesion. Microscopically, relatively small gaps were found in the muscularis at these points, showing that the muscular contraction, reducing the size of the original injury, must have played an important part in the healing process. Lesions made in the duodenum seemed to heal as readily as those made in the stomach.

The healing process, when studied microscopically in all the lesions, was found to conform closely to that described by Mann and others.

Group 2—In this group (surgical duodenal drainage) there were twenty consecutive experiments. In all, twenty animals, an ulcer or ulcers appeared in the jejunum from 0.5 to 2 cm distal to the line of anastomosis with the

stomach. The earliest ulcer was one discovered fourteen days after operation. The last animal in the series died from a large perforating ulcer of the jejunum four months after operation. The presence of ulcer was always determined by direct inspection at exploratory laparotomy or at necropsy. Gastric ulcers were never found in these or any other experiments in which surgical duodenal drainage



FIG. 3—Stomach of dog in Group 3 twenty-six days after operation. Chronic-looking ulcer at area 1 perforated causing general peritonitis and death. Small ulcer at area 3. Areas 2 and 4 healed.

alone was induced. The ulcers obtained in 100 per cent of experiments in this group were characteristically subacute or chronic in type, since they conformed precisely to those described by Mann and Williamson, I shall not discuss them further at this time.

Group 3—In this group (excision of gastric mucosa and surgical duodenal drainage at the same operation) there were twenty-eight consecutive experiments. Because of postmortem changes and other extraneous circumstances which marred some of the specimens, eight experiments were excluded from the series, in the other twenty, data were complete and satisfactory.

In this group the earliest observation on the stomach was four days and the latest ninety-five days after operation. In every experiment the stomach showed delay in healing (Fig. 2). Eighteen of the experiments were of more than one week's duration, in 50 per cent of these there were very definite ulcers of the lesser curvature of the stomach that grossly and microscopically presented the appearance of subacute or chronic peptic ulcer (Figs. 3 and 4).

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Delay in healing was very much more marked on the lesser curvature than on the greater. In the same stomach there were ulcers on the lesser curvature and healing or healed areas on the greater curvature (Fig 5). All the ulcers were found on the lesser curvature except in two experiments in which, besides the ulcer on the lesser curvature, ulcer was found on the greater curvature in the pyloric region. In general, healing of the pyloric region, even on the greater curvature, seemed to be relatively slower than healing of the fundic region of the stomach. The suture line in the anterior

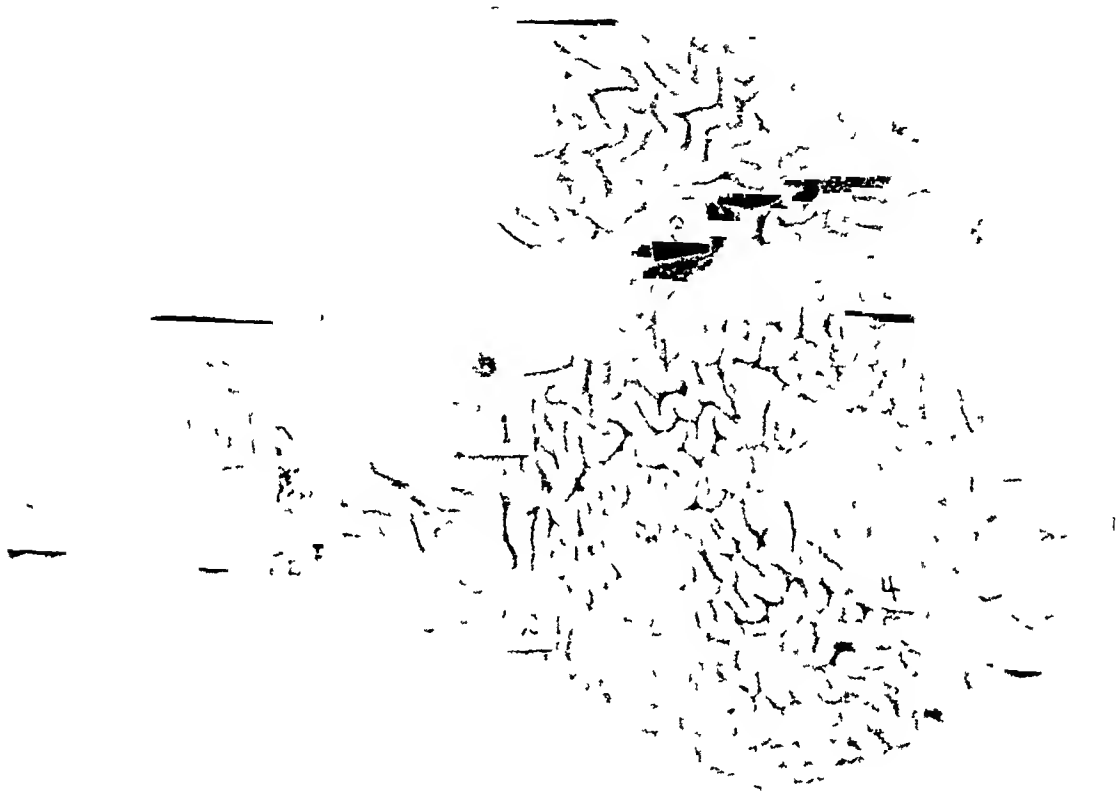


FIG 4—Stomach of dog in Group 4 one month after final operation. Typical ulcer chronic type at area 1 on lesser curvature. Smaller ulcer at area 3. Areas 2 and 4 on greater curvature healed.

wall of the stomach, though slightly retarded in healing, always healed satisfactorily, the rate of healing being about the same as that for lesions in the fundic region.

Of all the areas in the stomach investigated, the lesions in the fundus on the greater curvature showed the greatest tendency to heal normally and rapidly, although they healed more slowly than similar lesions made in Group 1 in which surgical duodenal drainage was not instituted (Fig 6).

The ulcers found in this group showed the characteristics of subacute and chronic ulcers already outlined. One had even perforated, and caused the death of the animal by acute diffuse peritonitis. Others were found on section to have perforated all layers of the stomach and were prevented from entering the general peritoneal cavity only by adhesions with the omentum or other organs.

The oldest of the ulcers was one found thirty-five days after operation.

the death of the animal being due to perforation of the ulcer that had formed in the jejunum. This was the cause of death of most of the animals and was the reason why more long-time experiments were not available in this group.

Group 4—In this group (surgical duodenal drainage followed in two weeks by excision of gastric mucosa) which is essentially the same as Group 3, there were twenty consecutive experiments, in all of which the data were complete and satisfactory. The earliest observation on the stomach was two days and the latest ninety days after the final operation. In every experi-

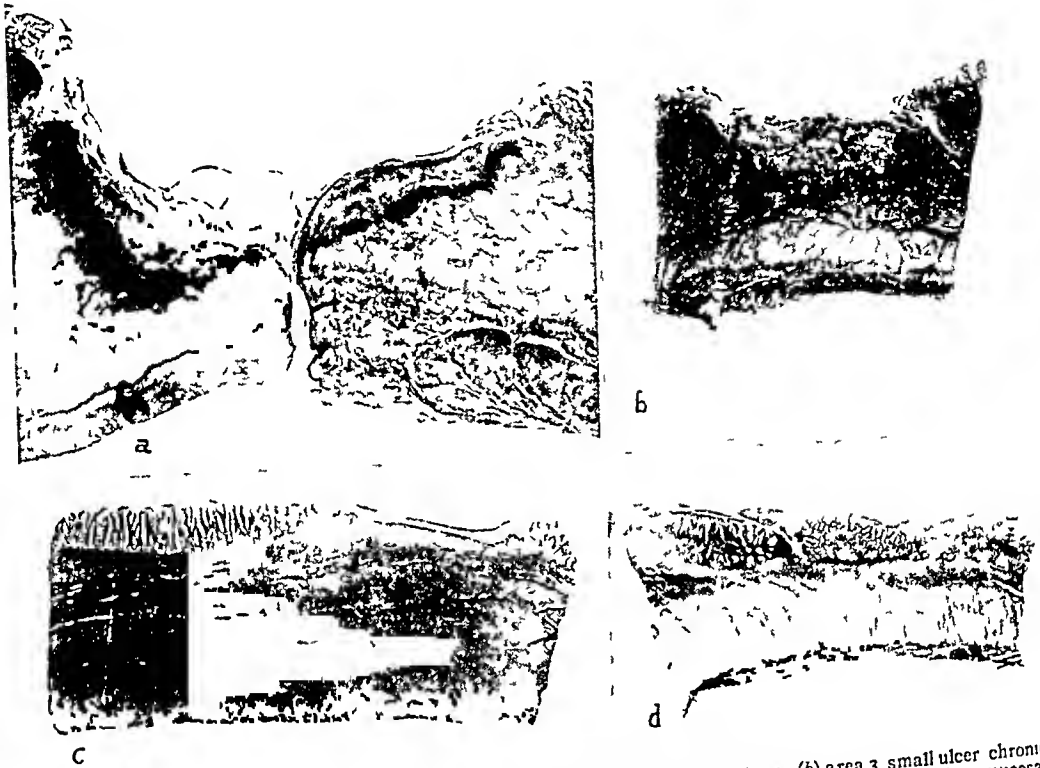


FIG 5 —(a) Area 1 perforated ulcer chronic type on lesser curvature, (b) area 3 small ulcer chronic type on lesser curvature and (c and d) areas 2 and 4 on greater curvature both with a complete mucosal covering consisting of almost normal mucosa in area 4 but only a single layer of cells in area 2. Twenty six days after operation. Group 3 ($\times 8$)

ment the stomach showed delay in healing. Sixteen of the experiments lasted more than one week, in 62 per cent of these there were very definite ulcers of the lesser curvature of the stomach that grossly and microscopically presented the appearance of subacute or chronic peptic ulcers (Fig 4).

The same characteristics of delayed healing as those noted in Group 3 were present in this group and the ulcers were equally characteristic of the chronic peptic ulcer. The oldest of the ulcers in this group was one found when the animal was killed under anaesthesia two months after the final operation.

DISCUSSION

The results of the experiments in Group 1 verify those of many other investigators who have all found that acute experimental lesions in the normal stomach always heal with great rapidity and apparent ease.

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The results of the experiments in Group 2 are very striking in that peptic ulcers developed in 100 per cent of experiments following surgical duodenal drainage after the method of Mann and Williamson. The ulcers induced by this method were characteristically chronic peptic ulcers resembling grossly and microscopically those found in the stomach and duodenum of man. Their site is important in that it bears the same relation to the stomach as that borne by the chronic duodenal ulcer in man, namely, just distal to the pylorus and at a point where the contents emptying from the stomach impinge most directly upon the flexed wall of the intestine.

The results in Groups 3 and 4 are equally as striking because factors have been introduced which in some way interfere with the inherent power of the stomach to heal, factors which not only prevent healing, but which do so to the greatest degree at exactly the region where the clinician most frequently encounters gastric ulcers, namely, the lesser curvature. These factors not only prevent healing but actually promote erosion and cause the formation of chronic looking ulcers that grossly and microscopically have the typical characteristics of subacute and chronic peptic ulcers. It is the effect of surgical duodenal drainage which introduces these factors.



FIG 6—Group 1 area 1 normal healing four days after operation showing the growing edge of mucosa consisting of a single layer of epithelial cells ($\times 150$)

The fourth group of experiments was undertaken because of certain things which had been learned from the first and second groups. (1) Acute lesions in the normal stomach healed in about two weeks, and (2) the earliest jejunal ulcer was found two weeks after surgical duodenal drainage. Therefore, the areas of mucosa in Group 4 were excised at a second operation two weeks after the institution of surgical duodenal drainage.

On the hypothesis that the same factors were probably responsible for both the jejunal ulcer and the interference with healing in the stomach, it was hoped by the two-stage operation to expose the acute lesions in the stomach to the hypothetical causative factors at a time when the latter had reached such a potentiality as to be able to induce the formation of jejunal ulcers in almost 100 per cent of cases. It was thought that by this method the conditions for the formation of chronic lesions of the stomach would be

at their optimum. The results were satisfactory and showed a slight increase in the incidence of unhealed, chronic lesions.

An extremely important and significant fact, shown very well by the photographs and photomicrographs, is that in the same stomach there were two types of lesion. One was the definite chronic type of peptic ulcer on the lesser curvature, the other was the healing or completely healed lesion on the greater curvature. This is important in evaluating possible nutritional factors in relation to the non-healing on the lesser curvature. It may be said to exclude largely the animal's lowered state of nutrition as the cause of non-healing and rather suggests that the lowered nutrition may be due, at least in part, to the peptic ulcer. Such a relationship often obtains in clinical peptic ulcer.

There is an anatomic difference between the lesser and greater curvatures of the stomach that may be of some importance. On the greater curvature the mucosa is loosely attached and is readily thrown into many folds and rugae which serve to protect a lesion of the stomach in this region mechanically. On the lesser curvature the mucosa is more closely attached and cannot so readily throw itself into folds for protection.

Moreover, the lesser curvature represents the line from which the stomach is suspended, this line being relatively fixed by the esophagus and the gastro-hepatic omentum and ligaments. The greater curvature, on the other hand, is relatively freely movable. The tension on the lesser curvature from the suspension of the stomach might conceivably interfere slightly with the blood supply. There is another and probably more real effect produced by its anatomic position. Mapping out the lines of force according to physical principles in the contracting stomach shows that they tend to converge largely at the pylorus and along the lesser curvature. This means that the greatest amount of friction and trauma will be administered to the stomach by its emptying contents in these regions.

In the normal gastro-intestinal tract there is a relative balance maintained between the alkali of the duodenum and the acid of the stomach. At the height of gastric digestion the amount of acid in the stomach will vary, depending on many factors, such as kind and amount of food, and it is possible that the acid may be relatively high. Later in the digestive period when the gastric contents are expelled from the stomach, whatever of free acid there may be present is neutralized in the duodenum.

Surgical duodenal drainage, shunting the alkali in the duodenum to the ileum and precluding the possibility of regurgitation of alkali as far as the region of the pylorus, causes an acid-alkali imbalance in the stomach and intestine into which it empties by the practically complete removal of alkali from the region.

Surgical duodenal drainage then, with its resultant acid-alkali imbalance, not only causes the spontaneous formation of ulcers that are similar to clinical duodenal ulcers in site, structure, and other characteristics, but also interferes with the inherent healing power of the stomach and often causes acute lesions

to develop into chronic lesions which are similar to clinical gastric ulcers in site, structure and other characteristics

Mann attributes the situation and chronicity of the jejunal ulcers following surgical duodenal drainage to a combination of two factors. One is chemical, the destructive action of free, unneutralized acid on cells, the other is mechanical, the ease with which young growing cells can be swept away and so prevented from repairing an ulcer.

The same explanation very probably holds true for the delayed healing and non-healing in the stomach. This disturbed function is especially marked on the lesser curvature, the area of the stomach that is physiologically most subject to mechanical forces of friction and irritation in emptying the gastric contents. Since the duodenal secretions have been shunted into the ileum no regurgitation of alkali into the stomach can take place and its interior is bathed continuously in a free and unneutralized acid medium.

SUMMARY

The literature on experimental peptic ulcer and the theories of the cause of ulcer have been reviewed. The characteristics of acute and chronic ulcer with some of the means that have been used to produce them experimentally have been briefly considered and the healing process, as studied grossly and microscopically, has been outlined.

A series of experiments performed by the author has been described in four groups. In the first the inherent power of the normal stomach to heal was verified. In the second, out of a series of twenty experiments in which the operation for surgical duodenal drainage was performed after the method of Mann and Williamson, jejunal ulcers of subacute and chronic types were produced in 100 per cent of the experiments.

In the third group, out of a series of twenty experiments in which small areas of gastric mucosa were excised and surgical duodenal drainage instituted at the same time, all areas showed delay in healing in 100 per cent of the experiments. In 50 per cent of all except the brief experiments, gastric ulcers of subacute and chronic type were produced on the lesser curvature while similar areas on the greater curvature healed.

In the fourth group out of a series of twenty experiments in which surgical duodenal drainage was instituted and followed two weeks later by the excision of small areas of gastric mucosa all areas showed delay in healing in 100 per cent of the experiments. In 62.5 per cent of the more prolonged experiments gastric ulcers of subacute and chronic type were produced on the lesser curvature while similar areas on the greater curvature healed.

An analysis of the conditions present and the factors operating emphasized the importance of the chemical and mechanical factors in the etiology of chronic peptic ulcer.

II A RONTGENOLOGIC STUDY OF EXPERIMENTAL CHRONIC ULCER

THIS study was made to add to the data already collected on other phases of experimental, chronic, peptic ulcer. The method of surgical duodenal drainage first reported by Mann and Williamson induces chronic peptic ulcers of the duodenum and jejunum that are grossly and microscopically almost indistinguishable from the chronic peptic ulcer encountered clinically. Such lesions occur in more than 90 per cent of experiments and lend themselves readily to rontgenologic study. In these experiments the presence of ulcers and their effect on gastric motility were studied fluoroscopically and photographically with the Rontgen-ray.

Nothing could be found in the literature on the rontgenology of experimental ulcer. A vast amount of work has been done on the experimental production of ulcer and a few observers have succeeded in producing lesions that resemble chronic ulcer. I reviewed this work in a previous paper and described a method of producing chronic ulcers in the stomach. Further review will not be made here.

Much has been written also on the value of the Rontgen-ray in the diagnosis of clinical peptic ulcer. Clinical gastro-intestinal rontgenology has, however, no direct bearing on this work other than in technical details, and no attempt will be made to review it here. The rontgenologic technic used in these experiments is essentially that described by Carman and is used in the gastro-intestinal examinations at the Mayo Clinic.

METHOD OF EXPERIMENTATION

Medium-sized dogs weighing from 10 to 15 kg., selected for their good nature and adaptability to handling, were used throughout the experiments. Operations were carried out under ether anæsthesia and aseptic technic. No rubber-covered or other intestinal clamps and no unabsorbable sutures were employed in any of the operative procedures. All Rontgen-ray examinations and all operations were carried out by me.

After each animal had received opaque meals, I examined it on several occasions under the fluoroscope and by means of rontgenograms to impress a normal gastro-intestinal picture on my mind, and to determine that each animal conformed to this normal picture. Examinations were always made with the animal in various positions, but it was found most satisfactory to take the rontgenogram with the animal in the prone position, belly resting on the plate and the Rontgen-ray tube above the animal's back and about eighteen inches from the plate.

In determining the most satisfactory opaque meal for routine use, three were tried. The first, called the barium meal, consisted of equal parts by weight of barium sulphate powder, gum acacia solution, and condensed milk. The gum acacia solution was made from lump gum acacia dissolved in water to form a syrupy solution of about the consistency of ordinary commercial corn syrup. The meal was administered to the dogs in the dosage of 15 gm for each kilogram of body weight. This meal has long been used as a

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standard for Rontgen-ray examinations of the gastro-intestinal tract in this laboratory. The second, the barium-meat meal, consisted of one-third by weight of cooked ground meat and two-thirds of barium meal. The amount administered was 15 gm for each kilogram of body weight. The third, the barium-sugar meal, consisted of equal parts by weight of cane sugar and barium meal administered in amounts equal to 15 gm for each kilogram of body weight.

Food was withheld for twenty-four hours preceding the examination and the dogs usually ate the opaque meals with relish. The fasting period was continued through the time of the examination. Following the ingestion of the meal the animals were examined at once under the fluoroscope and roentgenograms were taken within ten minutes. The size, shape, position and emptying characteristics of the stomach and duodenum were studied carefully. Other examinations, both fluoroscopic and roentgenographic, were made at intervals of three, five, and seven hours following the ingestion of the opaque meal. Between examinations animals were returned to their cages. The dogs soon became accus-

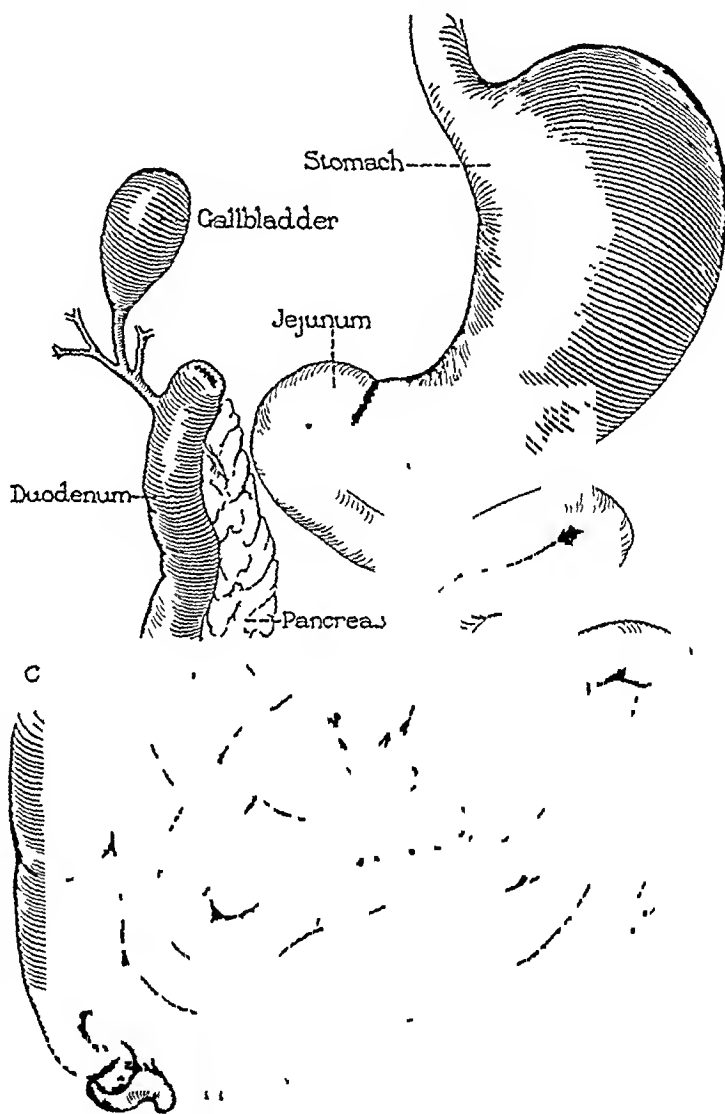


FIG. 1.—Diagram of the operative procedure of surgical duodenal drainage.

tomed to the procedures and were handled with great ease. After several examinations of the gastro-intestinal tract of the normal animal had demonstrated that the animal conformed to the normal picture, operation was performed in order to produce peptic ulcer.

The operative procedure of surgical duodenal drainage is as follows. The pylorus is severed, the distal end closed, the first part of the jejunum is severed and the proximal end closed. End-to-end anastomosis is then made between the proximal end of the severed pylorus and the distal end of the severed jejunum, and the continuity of the gastro-intestinal tract thus restored. Then, to form an outlet for the closed segment of gut consisting

of the duodenum and a small part of the first portion of the jejunum, a side-to-side anastomosis is made between this closed portion of jejunum and the lower ileum about 25 cm proximal to the ileocaecal valve (Fig 1) The result of this is to substitute the jejunum functionally and anatomically for the duodenum. The duodenum with its alkaline secretion and the alkaline bile and pancreatic juice is drained into the ileum at such a distance that regurgitation of alkali into the stomach or the gut immediately adjacent to it is precluded.

In large series of animals, in which this operation has been performed, ulcer has developed in almost 100 per cent. These ulcers tend to bleed and perforate and are grossly and microscopically almost indistinguishable from



FIG 2 —Stomach and anastomosed jejunum. Typical ulcer in jejunum 10 cm from surgical duodenal drainage (Dog J-167)

the chronic peptic ulcer found clinically in the duodenum of man. The ulcer occurs in the transplanted jejunum just distal to the pylorus, usually about 1 cm from the suture-line and at the point where the emptying acid chyme impinges on the wall of the flexed gut (Fig 2). It bears the same relationship to the pylorus as does the usual duodenal ulcer in man. By exploratory laparotomy it has been found possible to trace the development of these ulcers from small, acute, superficial lesions to large, deep, indurated craters. Because of these characteristics this type of ulcer seemed admirably suited to roentgenologic study.

After operation the animals received the usual care and diet, with milk and syrup added in order to maintain a higher level of nutrition. Roentgenologic examinations were made at approximately weekly intervals. After the ulcer had developed, examinations were often made at more frequent intervals, and exploratory laparotomy was also performed on some of the dogs in order to compare the gross and roentgenologic findings.

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RESULTS

Thirty-six roentgenologic examinations were made in twelve normal animals. In most cases the barium meal was used, though the barium-meat and barium-sugar meals were used in several for comparison.

The findings in the normal animals demonstrated in particular that the gastro-intestinal tract of the dog could be examined roentgenologically with considerable ease and precision. The shape of the dog's stomach was found slightly different from that of man, but it was nevertheless quite constant. In other respects the stomach and duodenum conformed very closely to the roentgenographic appearance of the stomach and duodenum of man (Figs 3a and 4a). The roentgenologic findings in this series of normal animals conformed very closely also to previous findings in large series of dogs examined at other times in this laboratory.

It was found that the barium meal passed on and left the stomach of



FIG. 3 — (a) Before operation, (b) twenty days after operation and (c) thirty-six days after operation showing tremendous gastric dilatation and retention (Dog I-25)

the normal animal empty in from three to four hours. The barium-meat meal passed through more slowly and with less regularity and the stomach was not entirely empty until five or six hours after the ingestion of the meal. The barium-sugar meal passed through more rapidly than the barium meal and left the stomach empty in three hours or less. Because of these findings the barium meal was adopted as the standard opaque meal, being in every way more uniform than the other two opaque meals tried.

Of the twelve animals studied as normal controls, six were studied for ulcer formation following surgical duodenal drainage. Thirty-seven roentgenologic examinations were made in these six animals after operation (Tabulation).

For the first two or three weeks following operation the roentgenologic characteristics of the stomach and intestine into which it emptied were almost indistinguishable from those in the normal animal (Fig 4c). The only difference was that following operation the pylorus did not function as efficiently as it did in the intact animal. The opaque meal tended to dribble somewhat through the pylorus even when the stomach was not in the contracting phase. The stomach, however, seemed to contract with the same rhythm and in the same manner whether or not operation had been performed.

About the third or fourth week after operation, a change was noticeable

Synopsis of Protocols of Six Animals Examined for Ulcer Formation

Dog	Date of operation	Number of examinations after operations	Röntgenologic examination		Exploratory laparotomy		Date of death	Necropsy findings	Remarks
			Date	Findings	Date	Findings			
H 812	4-8-25	7	5-7-25 5-13-25	Suspicious of ulcer Definite ulcer			7-13-25	Large typical chronic ulcer that had caused death by perforation	Typical chronic ulcer diagnosed by Röntgen-ray and verified at necropsy
I 24	4-23-25	7	5-27-25 8-7-25	Suspicious of ulcer More suspicious			8-18-25	Subacute ulcer that had caused death by perforation	Subacute ulcer suspected by Röntgen-ray and verified at necropsy
I 25	4-23-25	2	5-29-25	Stomach tremendously dilated, ulcer surmised			6-12-25	Subacute ulcer that had caused death by perforation	Subacute ulcer suspected by Röntgen-ray and verified at necropsy
J 99	4-26-26	9			6-17-26	No ulcer present and entire gastro-intestinal tract apparently normal	7-1-26	Ulcer that had perforated in the acute developing stage and caused death	Acute ulcer Röntgen-ray and exploratory laparotomy failed to find the ulcer which no doubt developed only a few days before death
J 118	4-26-26	9	5-26-26 6-2-26 6-28-26	Definite ulcer Ulcer grown larger Ulcer smaller and less distinct	6-3-26 6-17-26	Large chronic ulcer Ulcer grown larger (gastro-enterostomy performed)	7-2-26	Perforating acute ulcer opposite the gastro-enteric stoma. Original ulcer diagnosed by Röntgen-ray had healed considerably	Typical chronic ulcer diagnosed by Röntgen-ray and verified by exploration. Partially healed as seen in Röntgen-ray verified by necropsy
J 167	5-4-26	3	5-26-26	Definite ulcer	6-3-26	Large chronic ulcer that had apparently perforated within 2 or 3 hours preceding exploration. Gastro-enterostomy performed in the hope of saving animal. Perforation closed	6-4-26	Considerable peritonitis as found at exploration. Large perforating ulcer as repaired at exploration	Typical chronic ulcer diagnosed by Röntgen-ray and verified by exploration and necropsy

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in the animals. The stomach did not empty quite as fast as it had during the first two weeks and there was a little tendency toward gastric stasis (Fig. 3*b*), this in spite of the fact that the actual contractions of the stomach seemed little altered. It was about this time that the outline of the intestine just distal to the pylorus began to show irregularity which in later examinations resolved itself into a definite ulcer-crater (Fig. 4*b, c* and *f*). In one animal the gastric stasis became so marked that the shadow of the stomach

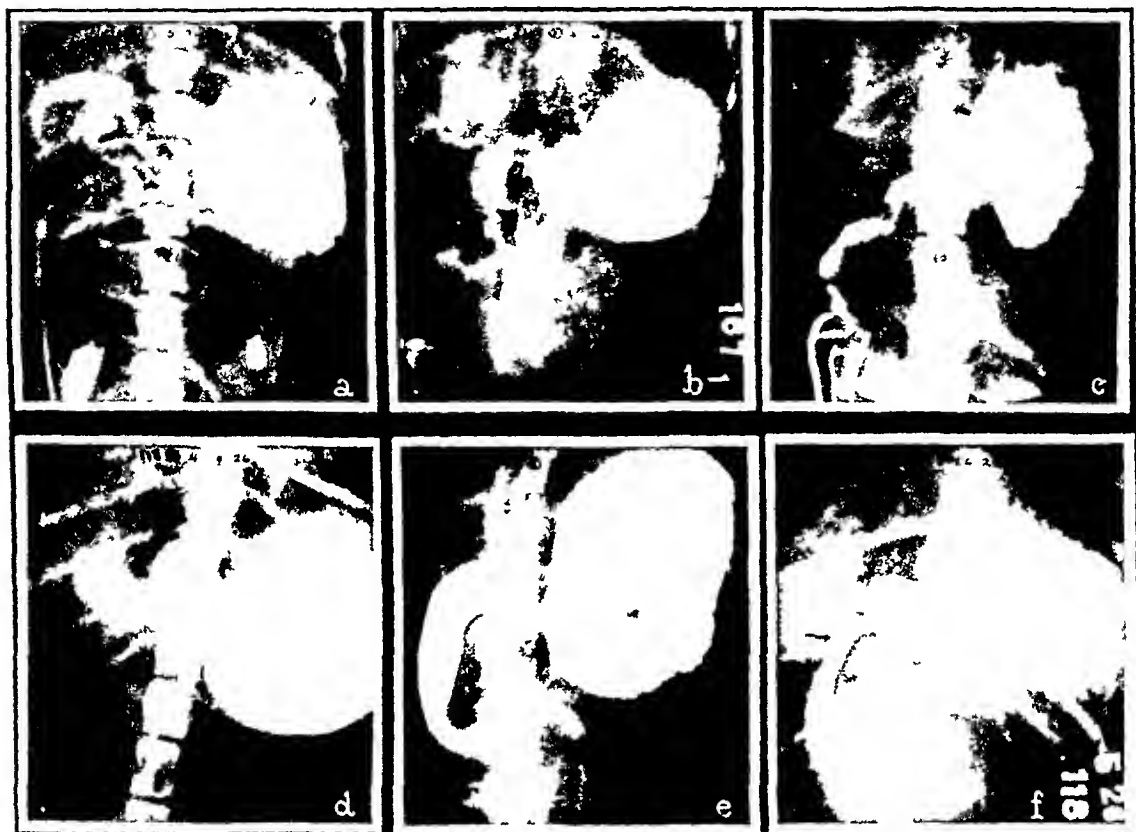


FIG. 4—(a) Before operation, (b) twenty-two days after operation, showing ulcer-crater, (c) thirty days after operation showing enlargement of crater, (d) before operation, (e) a few days after operation showing normal tract and (f) thirty days after operation showing ulcer-crater (Dog J-167 *a, b*, and *c*) and (Dog J-118 *d, e* and *f*)

filled almost the entire upper abdomen and made further roentgenologic examination of little value (Fig. 3*c*).

In every one of the animals an ulcer appeared at the usual site of ulcer formation following surgical duodenal drainage. Of the six ulcers, three were typically chronic in type and each of them was diagnosed by the Rontgen-ray. Two others were of the subacute type and, although suspected at fluoroscopic examination, were not depicted with certainty in the roentgenograms. One was an acute ulcer that apparently formed after the last Rontgen-ray examination and just before the animal's death.

It has been found in a few experiments in a large series that the usual chronic ulcer does not appear but instead an acute ulcer forms very rapidly and perforates within twenty-four or forty-eight hours from the time of its first appearance.

In one animal in which a large crater-shaped, indurated ulcer was demon-

strated roentgenologically and at exploration, the stomach was anastomosed to a loop of jejunum about 50 cm distal to that containing the ulcer. A large stoma was made in order that the greater part of the gastric contents might empty through it. Following this operation, the large ulcer just distal to the pylorus became much smaller and more difficult to depict with the Röntgen-ray. At necropsy, fifteen days later, this ulcer had lost its induration and deep crater-like shape, and had healed considerably, although not as rapidly as the healing described by Mann after gastro-enterostomy and pyloric exclusion, to protect the ulcer completely from the acid chyme.

DISCUSSION

It was to be expected that the high-protein, barium-meat meal would pass through the stomach slowly and the high-carbohydrate barium-sugar meal rapidly. It is well known that the period of gastric digestion for meat is long while that for sugar is short.

The roentgenologic similarity between the gastro-intestinal tract of the dog and of man, as demonstrated in these experiments, brings experimental data on gastro-intestinal physiology and pathology in the dog into correspondingly closer relationship with clinical problems.

The characteristics of the stomach immediately following surgical duodenal drainage were almost indistinguishable from those in the normal animal. The operative procedure changed very radically whatever inter-relationship there may have been normally between the acid-containing stomach and the alkali-containing duodenum. In spite of this the motility of the stomach was essentially unchanged until after the ulcer had commenced to form. After it had formed, gastric peristalsis seemed still essentially normal, although the gastric contents did not seem to empty quite so readily. It is most probable that the intestine into which the stomach emptied was responsible for the interference with the emptying process, and that either a mechanical obstruction was offered by the ulcer or else a spasm of the intestine was caused by the ulcer. Cicatricial contraction of the suture-line was not a factor, for inspection at necropsy failed to show any narrowing of the lumen at this point.

The fact that experimental peptic ulcers were depicted roentgenologically needs little comment. Röntgenograms of the three large chronic ulcers showed unmistakable craters. In one of these the healing process following gastro-enterostomy was detected. Two other subacute ulcers were suspected fluoroscopically, but plates showing a definite crater could not be obtained. The relative shallowness of the ulcers probably accounts for this failure. An acute ulcer was never found at any Röntgen-ray examination and, even at exploration fourteen days before death, no ulcer was present. As already suggested, this ulcer is one of the type occasionally encountered that develops and perforates with extreme rapidity.

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SUMMARY

Twelve normal dogs were given opaque meals, after which roentgenologic examinations of the gastro-intestinal tract were made. Such examinations were very satisfactory and were found similar to those of human subjects. Following the study of the normal tract, six of the dogs were studied for ulcer formation following surgical duodenal drainage as described originally by Mann and Williamson. Ulcers developed in all of the six dogs. Three were typical of the chronic type with deep craters, roentgenograms of each were obtained. Two were subacute lesions, suspected at fluoroscopic examination but not definitely shown in the roentgenograms. One was an acute ulcer and apparently developed and perforated suddenly after the last Rontgen-ray examination. In one of the chronic ulcers the healing process following gastro-enterostomy was observed.

The feasibility of roentgenologic study of experimental peptic ulcer was demonstrated.

Motor changes of the gastric musculature could not be detected as etiologic factors in the production of these ulcers.

III HEALING OF EXPERIMENTAL PEPTIC ULCER AFTER GASTRO-ENTEROSTOMY

SURGICAL duodenal drainage induces the formation of chronic types of peptic ulcer in the jejunum of dogs in more than 90 per cent of experiments. The ulcers often bleed and perforate and, in gross and microscopic characteristics and in their relation to the pylorus, are practically indistinguishable from peptic ulcers of the duodenum found in man. Such ulcers seem admirably suited for studying the effects of gastro-enterostomy, a treatment used so frequently in clinical cases of peptic ulcer.

LITERATURE

Mann and Williamson devised the operation for surgical duodenal drainage. In their first experiments they transplanted the common bile duct and pancreatic ducts into the ileum, thereby greatly decreasing the alkalinity of the duodenum. Following this procedure they found typical chronic peptic ulcers in the duodenum just distal to the pylorus in ten of thirty-one experiments. In later experiments they modified the procedure by draining the entire duodenum into the ileum, and anastomosing the jejunum to the pylorus so that anatomically the jejunum took the place of the duodenum. They found typical chronic peptic ulcers in the jejunum just distal to the pylorus in more than 90 per cent of such experiments.

In previous pages I have reviewed the literature on the production and the healing of peptic ulcers in experimental animals. I described the operation for surgical duodenal drainage, reported a method of producing typical chronic ulcer on the lesser curvature of the stomach in dogs, and presented some observations on the healing process in the gastric mucosa of dogs. Mann has studied in detail the healing process in peptic ulcer of the jejunum of the dog. Caylor and Kennedy have described the healing process in peptic

ulcer found in man. In a roentgenologic study of experimental ulcer I reported an experiment in which following simple gastro-enterostomy a very large chronic type of peptic ulcer showed definite evidence of healing both roentgenologically and at necropsy.

The literature with reference to the clinical use of gastro-enterostomy is too voluminous for consideration here. It is sufficient to say that gastro-enterostomy is one of the most commonly employed of surgical measures in treating clinical peptic ulcer.

METHODS OF EXPERIMENTATION

Normal healthy dogs were used in all experiments and for all operative procedures ether anaesthesia and aseptic technic were employed. No rubber-covered or other intestinal clamps and no unabsorbable sutures were used in any of the operations. After the operation for surgical duodenal drainage into the ileum the dogs received the usual care of normal animals, with milk and syrup added to their diet in order to maintain a better state of nutrition. They seemed to stand the operation well and usually remained in good condition until the ulcer of the jejunum, developing at the usual site of ulceration following surgical duodenal drainage, reached a considerable degree of chronicity. In large numbers of dogs following this operation, it has been found that the ulcer usually begins to form from two to six weeks after operation and steadily increases in size and chronicity until perforation of the ulcer and death of the dog occur several weeks or months later. The base of such an ulcer frequently adheres to the omentum or other adjacent tissues so that often the ulcer reaches a considerable depth and degree of induration before perforation into the general peritoneal cavity takes place.

Exploratory laparotomy was performed in this series of experiments from three to nine weeks following surgical duodenal drainage. The ulcer of the jejunum was in every case carefully examined and its size, shape, depth, and degree of induration recorded.

After this a loop of jejunum about 20 to 40 cm. distal to that containing the ulcer was brought into place and a gastro-enteric stoma made in the usual manner in the anterior wall of the stomach about 4 cm. proximal to the pylorus. An isoperistaltic loop was used and the stoma made large enough for the greater part of the gastric contents to empty through it.

Necropsy was performed on each dog at various intervals after gastro-enterostomy. The ulcer of the jejunum was carefully examined and its size, shape, depth, and degree of induration recorded and compared with the characteristics of the ulcer previous to gastro-enterostomy.

RESULTS

The operation for surgical duodenal drainage into the ileum was performed in nine healthy, normal dogs. Exploratory laparotomy was performed at various intervals from twenty to sixty-five days afterwards. A peptic ulcer was found in the jejunum of every dog (Fig. 1). At the same laparotomy gastro-enterostomy was performed in each dog.

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The intervals between gastro-enterostomy and necropsy varied from four to sixteen days. In every case the ulcers showed unmistakable evidence of healing (Fig 2). In two experiments small but typical chronic ulcers had healed entirely in ten and fifteen days, respectively, after gastro-enterostomy. In another experiment a typical indurated chronic ulcer, measuring at exploration 1 cm in diameter and 0.5 cm in depth, had healed almost completely in a period of sixteen days (Fig 3).

The rate of healing of the ulcers in these experiments after gastro-

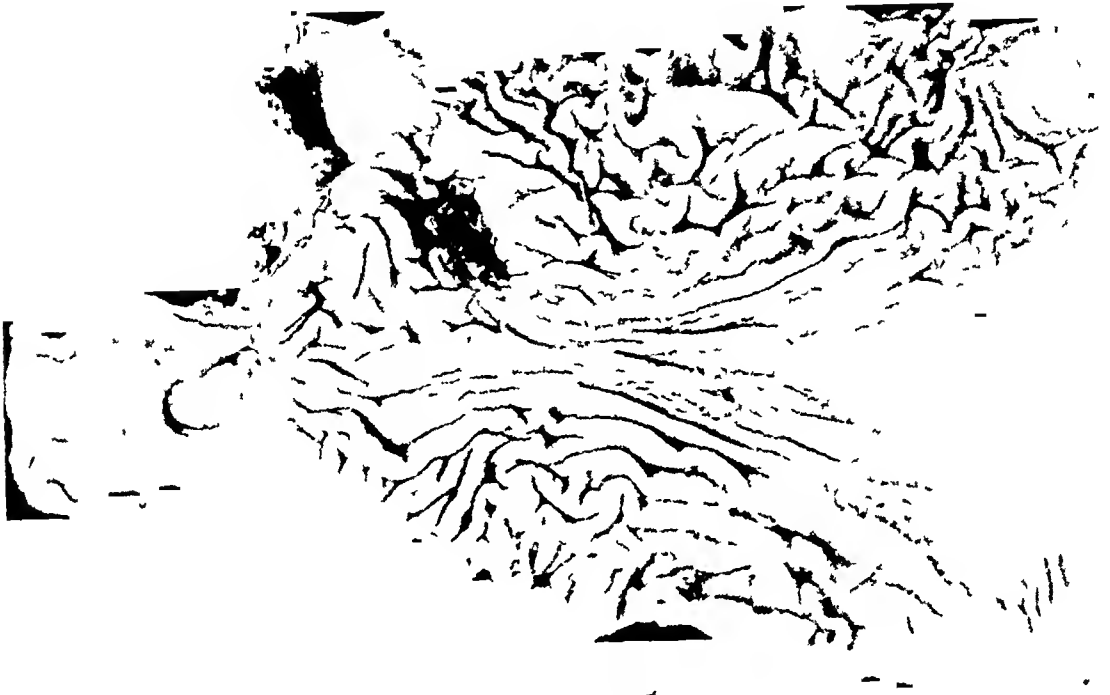


FIG 1.—Typical ulcer of jejunum following surgical duodenal drainage. Site of gastro-enterostomy performed a few hours previously in the stomach also shown.

enterostomy was in direct proportion to the size and degree of chronicity of the ulcer. As might be expected in the limited time allowed in the experiments, healing was more complete in small than in large ulcers (Tabulation).

The ulcers were also studied microscopically. All those studied showed evidence of healing. The inflammatory reaction and the induration of the ulcer seemed to subside first. Granulation tissue replaced the dirty, necrotic base and margins and gradually filled in the crater of the ulcer (Figs 4 and 5). At the same time epithelial cells grew out in a single layer and covered the granulation tissue. The process continued until, in the completely healed lesions previously mentioned, the entire area of the former ulcer was covered with epithelium which formed atypical glands and finally simulated in many respects the normal mucosa of the intestine.

Healing of these ulcers, however, was not as rapid and clean and orderly as that described by Mann who studied the healing of peptic ulcer of the jejunum after completely occluding the pylorus and draining all the gastric

contents through a gastro-enteric stoma. By his method he completely protected the ulcer from all contact with acid chyme and thereby established ideal conditions for the healing process.

Besides the healing ulcers found at necropsy, new developing ulcers were usually found in the efferent loop of jejunum just opposite the gastro-enteric stoma. These ulcers were found always at the point in the efferent loop against which the emptying acid chyme impinged most directly.

DISCUSSION

Typical chronic peptic ulcers were found in 100 per cent of these experiments with surgical duodenal drainage. The ulcers formed at the usual site,

just distal to the pylorus and at the point where the acid chyme in emptying from the stomach impinged most directly against the wall of the intestine. Mann likens the pylorus to a nozzle, through which the gastric contents are emptied in a jet-like stream.

Under normal conditions the stomach empties its acid chyme into a portion of intestine which contains a highly alkaline secretion capable of neutralizing considerable amounts of acid. Under the conditions resulting from surgical duodenal drainage this is no longer the case. A highly acid chyme is forcibly ejected

FIG. 2.—Healing ulcer. Arrow indicates ulcer pointer indicates gastro-enteric stoma indistinctly seen through incision in the stomach. Seven days after gastro enterostomy.

through the pyloric nozzle by the impulse of gastric contractions and impinges against the wall of a portion of intestine which contains little or no alkali.

The relative constancy in occurrence and site of the ulcers following surgical duodenal drainage seems partly, if not completely, explained by these factors: the absence of alkali to neutralize the acid ejection from the stomach and the manner in which the acid chyme is repeatedly ejected against a relatively circumscribed area of the wall of the intestine.

In these experiments 100 per cent of typical chronic peptic ulcers showed definite signs of healing after gastro-enterostomy, and in two experiments healing was complete. The gastro-enteric stoma was designed to empty the greater part of the gastric contents and to decrease the amount and the force of acid ejections from the pylorus. The result was that the original ulcer of the jejunum began to heal, but at the same time a new ulcer began to form

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Synopsis of the Protocols of the Nine Experiments with Healing Ulcer

Experiment	Surgical duodenal drainage Date 1926	Exploration and gastro-enterostomy			Necropsy		
		Date, 1926	Interval, days	Findings and Remarks	Date, 1926	Interval, days	Findings and Remarks
1	4-26	6-3 6-17	38 52	Chronic ulcer 1 cm in diameter (No gastro-enterostomy) Chronic ulcer 2 by 1.5 cm, 1 cm in depth	7-2	15	Marked healing Induration has subsided Ulcer only 1 by 1.8 cm in diameter and 0.3 cm in depth
2	6-25	7-15	20	Two subacute ulcers, each 0.5 cm in diameter and about 0.4 cm in depth	7-30	15	Both ulcers entirely healed Difficult to find scars
3	6-25	7-15	20	Two subacute ulcers, one 0.3 cm in diameter and 0.3 cm in depth, the other 0.6 cm in diameter and 0.2 cm in depth	7-24	9	Both ulcers entirely healed Difficult to find scars
4	7-5	9-8	65	Chronic ulcer 1 cm in diameter and 0.5 cm in depth	9-18	10	Marked healing Induration has subsided Ulcer now 0.6 cm in diameter and 0.1 cm in depth
5	7-19	9-8	51	Subacute ulcer 1.5 cm in diameter and 0.2 cm in depth	9-15	7	Definite healing Induration has subsided Size unchanged
6	7-19	9-9	52	Chronic ulcer 1.5 cm in diameter and 0.7 cm in depth	9-19	10	Definite healing Induration has subsided Diameter of ulcer unchanged, depth now 0.2 cm
7	7-19	9-9	52	Chronic ulcer 1 cm in diameter and 0.5 cm in depth	9-25	16	Marked healing, almost complete Superficial scar-like area 0.4 cm in diameter remains
8	7-22	9-10	50	Chronic ulcer 1.5 cm in diameter and 0.5 cm in depth	9-14	4	Definite healing Induration has subsided Diameter of ulcer unchanged, depth now 0.2 cm
9	7-29	9-13	46	Chronic ulcer 1.5 cm in diameter and 0.7 cm in depth	9-20	7	Marked healing Induration has subsided Ulcer now 0.7 by 0.6 cm and 0.1 cm in depth

in the loop leading from the gastro-enteric stoma. The new ulcer formed opposite the stoma at the point where the acid chyme emptying from the stomach impinged most directly and forcibly against the wall of the intestine.

A gastro-enteric stoma situated, in these experiments, only a short distance from the site of the original ulcer could not appreciably alter the concentration of acid present in the region of the ulcer by any process of neutralization. The alkaline secretions were drained too far distally in the intestinal tract for that possibility to be entertained. Gastro-enterostomy apparently

introduced merely an accessory outlet for the acid chyme of the stomach, thereby decreasing the amount and the force of the ejections from the pylorus and so protecting the original ulcer from the degree of trauma to which it had been subjected in the developing stages. This explanation seems to be substantiated by the development of the new ulcer opposite the stoma

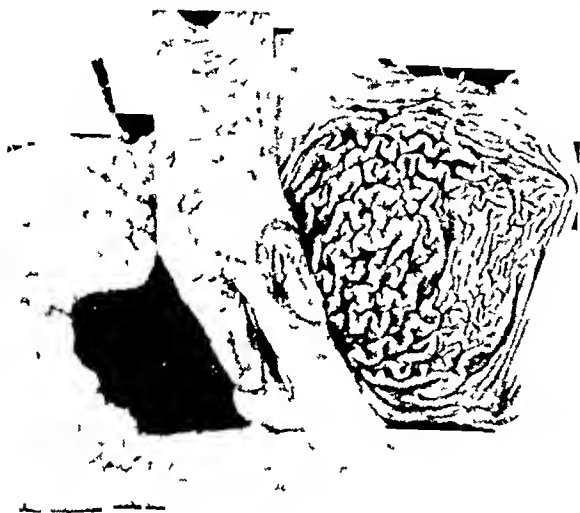


FIG 3 —Healing ulcer. Arrow indicates ulcer which has healed almost entirely. Large newly forming ulcer is just to the right of the gastro-enteric stoma and in the efferent loop. Sixteen days after gastro-enterostomy.

in the efferent loop of the anastomosis. The stoma was designed to bear the brunt of the burden of emptying the stomach, and therefore the same factors that induced the original ulceration were made to operate at the point where the new ulcer developed.

In these experiments gastro-enterostomy after surgical duodenal drainage could not introduce alkali into the ulcer-bearing area, but promoted healing of chronic ulcers apparently by distributing the forces of gastric ejections over larger areas. Gastro-enterostomy as employed in clinical cases of peptic ulcer may not only distribute the force of gastric ejections, but also may introduce alkali into the ulcer-bearing area by way of the afferent loop.

From the data of experiments the presence of adequate amounts of alkali in the ulcer-bearing area, and the proper distribution of the force of ejections from the emptying stomach, are suggested as having an important bearing on the etiology and treatment of chronic peptic ulcer.

SUMMARY

Some previous work on the production and the healing of peptic ulcers in experimental animals and in man was briefly reviewed. Experiments were performed in which, following the operation for surgical duodenal drainage in nine dogs, typical chronic peptic ulcers of the jejunum developed in 100

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per cent of the cases. Ulcers were carefully measured at exploratory laparotomy. Gastro-enterostomy designed to empty the greater part of the gastric

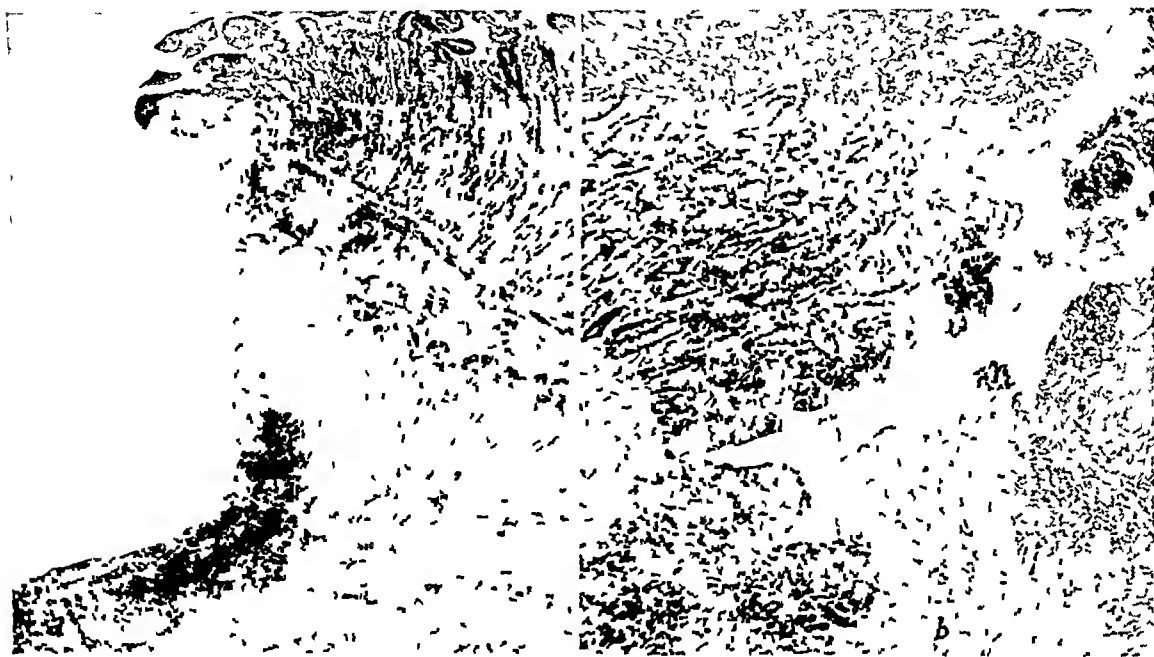


FIG 4 —(a) Typical margin of the usual chronic ulcer after surgical duodenal drainage ($\times 25$). Note necrotic and infiltrated edges and wedge-shaped submucosa. (b) Margin of typical healing ulcer four days after gastro-enterostomy ($\times 60$). Note granulation tissue filling in the crater and mucosa growing out to cover it.

contents through the new stoma was then performed in all animals. At necropsy, performed at various intervals after gastro-enterostomy, evidence of healing was present in 100 per cent of the ulcers. In two experiments the ulcers healed entirely

and in one experiment a deep chronic ulcer, 1 cm in diameter and 0.5 cm in depth, healed almost completely in sixteen days following gastro-enterostomy. The rate of healing in the ulcers was directly proportional to the size and chronicity of the ulcer and to the length of time after gastro-enterostomy. Coincident with the healing of the original ulcers new ulcers formed in the efferent

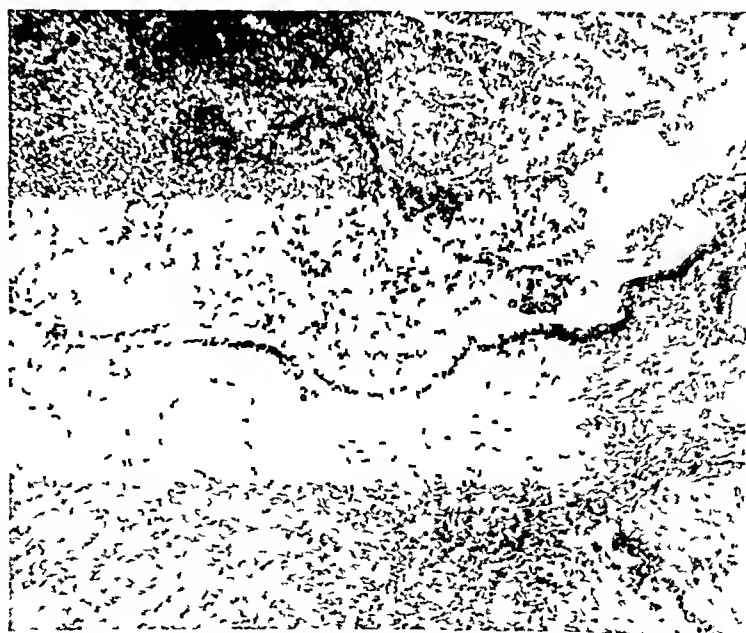


FIG 5 —Margin of typical healing ulcer seven days after gastro-enterostomy ($\times 60$). Note layer of epithelium extending far out over the area of granulation tissue.

loops of the gastro-enteric anastomosis. The acid-alkali imbalance following surgical duodenal drainage, and the force with which the contents emptying

from the stomach impinged directly on a relatively circumscribed area of the intestinal wall, were suggested as having an important bearing on the formation of chronic ulcers after surgical duodenal drainage. The healing of these ulcers, with the coincidental formation of new ulcers in the efferent loop, was brought about by gastro-enterostomy and the consequent alteration in the factors that caused ulceration. The probable bearing of the same factors on the etiology and treatment of clinical chronic peptic ulcer was mentioned.

BIBLIOGRAPHY—PART I

- ¹ Baillie, M. Quoted by Bolton
- ² Bauhin, J. Quoted by Lebert
- ³ Bedarida, N. V. Produzione sperimentale di ulcera gastrica. Arch ital di chir, Bologna, 1924, vol ix, pp 109-147 (Abst Jour Am Med Assn, 1924, vol lxxvii, p 1738)
- ⁴ Bolton, C. Ulcer of the Stomach. London, Arnold, 1913, 396 pp
- ⁵ Brinton, William. Diseases of the Stomach. 2nd Ed, London, Churchill, 1864, vol cxvii, p 133
- ⁶ Butsch, J. L. Ulcers of the Gastro-intestinal Tract with Special Reference to Gastro-jejunal Ulcers. Papers from The Mayo Foundation and Medical School of the University of Minnesota, 1915-1920, vol i, pp 57-84
- ⁷ Caylor, H. D. The Healing of the Gastric Ulcer in Man. ANNALS OF SURGERY, 1926, vol lxxviii, pp 350-356
- ⁸ Celsus. Quoted by Bolton
- ⁹ Cohnheim, J. Lectures on General Pathology, London, New Sydenham Society, 1890, vol iii, p 879
- ¹⁰ Cramer, Friedrich. Ueber die Ablosung der Magenschleimhaut durch die Sondirung und ihre Folgen. Munchen med Wchnschr, 1891, vol xxxviii, pp 903-904
- ¹¹ Cruveilhier, Jean. Anat pathologique die corps humain. Paris, J. B. Bailliere, 1829-1842, 2 vs. Quoted by Bolton
- ¹² Dott, N. M., and Lim, R. K. S. Experimental Jejunal Ulcer. Quarterly Jour of Exper Physiol, 1923, supplement (Proc xi int Physiol Cong), Edinburgh, pp 109-110
- ¹³ Dragstedt, L. R., and Vaughan, A. M. Gastric Ulcer Studies. Arch Surg, 1924, vol viii, pp 791-810
- ¹⁴ Durante, L. The Trophic Element in the Origin of Gastric Ulcer. Surg, Gynec and Obst, 1916, vol xxii, pp 399-405
- ¹⁵ Exalto, J. Ulcus jejuni nach Gastroenterostomie. Mitt a d Grenzgeb d Med u Chir, 1911, vol xxiii, pp 13-41
- ¹⁶ Fenwick, S., and Fenwick, W. S. Ulcer of the Stomach and Duodenum and its Consequences. London, J and A Churchill, 1900, pp 80, 82, 83, 93
- ¹⁷ Friedman, J. C., and Hamberger, W. W. Experimental Chronic Gastric Ulcer. Jour Am Med Assn, 1914, vol lxi, pp 380-384
- ¹⁸ Greggio, Ettore. Des ulceres gastro-duodenaux. Arch de med exper et d'anat path, 1916-1917, vol xxvii, pp 533-590
- ¹⁹ Griffin, L., and Vassale, G. Ueber die Reproduktion der Magenschleimhaut. Beitr z path Anat u z allg Path, 1888, vol iii, pp 425-448
- ²⁰ Hoffman, Albert. Experimental Gastric and Duodenal Inflammation and Ulcer. Amer Jour Med Sc, 1925, vol clxx, pp 212-219
- ²¹ Ivy, A. C. Studies on Gastric and Duodenal Ulcer. Jour Am Med Assn, 1920, vol lxxv, pp 1540-1542

OBSERVATIONS ON PEPTIC ULCER

- ²² Kehler, J K W Ueber die Ursache des runden Magengeschwures Mitt a d Grenzgeb d Med u Chir, 1914, vol xxvii, pp 679-693
- ²³ Kennedy, R L J Etiology and Healing Process of Duodenal Ulcer in Melena Neonatorum Am Jour Dis Child, 1926, vol xxxi, pp 631-638
- ²⁴ Lebert, H Die Krankheiten des Magens Tubingen, H Laupp, 1878, p 180
- ²⁵ Leube, W O Bemerkungen uber die Ablosung der Magenschleimhaut durch die Magensonde und ihre Folgen Deutsch Arch f klin Med, 1876, vol xviii, pp 496-505
- ²⁶ Mann, F C Production and Healing of Peptic Ulcer, an Experimental Study Minn Med, 1925, vol viii, pp 638-640
- ²⁷ Mann, F C The Chemical and Mechanical Factors in Experimentally Produced Peptic Ulcer Surg Clin N Amer, 1925, vol v, pp 753-775
- ²⁸ Mann, F C, and Williamson, C S The Experimental Production of Peptic Ulcer ANNALS OF SURGERY, 1923, vol lxxvii, pp 409-422
- ²⁹ Matthes, M Untersuchungen uber die Pathogenese des Ulcus rotundum ventriculi und uber den Einfluss von Verdauungsenzym auf lebendes und todes Gewebe Beitr z path Anat u z allg Path, 1893, vol xiii, pp 309-364
- ³⁰ Mayo, W J Ulcer of the Stomach and Duodenum with Special Reference to the End Results ANNALS OF SURGERY, 1911, vol liv, pp 313-320
- ³¹ Pavy, F W On Gastric Erosion Guy's Hosp Reports, 1867, 3d Series, vol xiii, pp 494-509
- ³² Quincke and Daettwyler Quoted by Bolton
- ³³ Robertson, H E, and Hargis, E H Duodenal Ulcer An Anatomical Study Med Clin N Amer, 1925, vol viii, pp 1065-1092
- ³⁴ Rosenow, E C The Causation of Gastric and Duodenal Ulcer by Streptococci Jour Infect Dis, 1916, vol xix, pp 333-384
- ³⁵ Rosenow, E C The Specificity of the Streptococcus of Gastro-duodenal Ulcer and Certain Factors Determining its Localization Jour Infect Dis, 1923, vol xxxiii, pp 248-268
- ³⁶ Turck, F B Ulcer of the Stomach Pathogenesis and Pathology Jour Am Med Assn, 1906, vol xli, pp 1753-1763
- ³⁷ Vedova, R D Ricerche sperimentali sulla pathogenesi dell' ulcera gastrica Suppl Polichin, 1900, vol vi, pp 1153-1156
- ³⁸ Virchow, R Quoted by Bolton
- ³⁹ Ziemssen, V Zur Technik der Localbehandlung des Magens Deutsch Arch f klin Med, 1872, vol x, pp 65-72

BIBLIOGRAPHY—PART II

- ¹ Carman, R D The Rontgen Diagnosis of Diseases of the Alimentary Canal Philadelphia, W B Saunders Co, 1920, pp 676
- ² Mann, F C, and Williamson, C S The Experimental Production of Peptic Ulcer ANNALS OF SURGERY, 1923, vol lxxvii, pp 409-422
- ³ Mann, F C The Chemical and Mechanical Factors in Experimentally Produced Peptic Ulcer Surg Clin N Amer, 1925, vol v, pp 753-775
- ⁴ Morton, C B Observations on Peptic Ulcer I A Method of Producing Chronic Gastric Ulcer A Consideration of Etiology (In Press)

BIBLIOGRAPHY—PART III

- ¹ Caylor, H D The Healing of the Gastric Ulcer in Man ANNALS OF SURGERY, 1926, vol lxxxi, pp 350-356

- ² Kennedy, R L J Etiology and Healing Process of Duodenal Ulcer in Melena Neonatorum Am Jour Dis Child, 1926, vol xxxi, pp 631-638
- ³ Mann, F C Production and Healing of Peptic Ulcer, an Experimental Study Minn Med, 1925, vol viii, pp 638-640
- ⁴ Mann, F C The Chemical and Mechanical Factors in Experimentally Produced Peptic Ulcer Surg Clin N Amer, 1925, vol v, pp 753-775
- ⁵ Mann, F C, and Williamson, C S The Experimental Production of Peptic Ulcer ANNALS OF SURGERY, 1923, vol lxxvii, pp 409-422
- ⁶ Morton, C B Observations on Peptic Ulcer I A Method of Producing Chronic Gastric Ulcer A Consideration of Etiology (In Press)
- ⁷ Morton, C B Observations on Peptic Ulcer II A Rontgenologic Study of Experimentally Produced Chronic Ulcers (In Press)

THE SURGICAL PATHOLOGY OF THE GALL-BLADDER *

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CHOLECYSTITIS as seen by the surgeon is one of a group of closely associated lesions which includes hepatitis, cholangitis, pancreatitis, appendicitis, and in many cases duodenal ulcer. These lesions, with the exception of ulcer and appendicitis, are in most instances complications and sequels of cholecystitis, and to them can be attributed most of the morbidity and mortality of the disease. Dysfunction of the gall-bladder may be the result of infectious, mechanical, chemical, metabolic, and nervous factors. The newer knowledge of disease of the biliary tract will come from an understanding of its innervation. There is in all likelihood a sphincteric mechanism under sympathetic control in the cystic duct as well as at the termination of the common duct disturbance of which may be a cause of disease in a manner similar to sphincter spasm in cases of cardiospasm, pylorospasm, Hirschsprung's disease, and many cases of idiopathic hydronephrosis. The exciting cause of cholecystitis is infection for which there are many predisposing factors of more or less importance. The fact that the greater number of patients having disease of the gall-bladder are entirely relieved of their symptoms after its removal, while many who have had only a drainage operation suffer a recurrence of symptoms, supports the belief that the gall-bladder regardless of the mechanism of its implication is the keystone of the situation. Cholecystitis in most instances is a chronic insidious process whose early symptoms are disregarded by the patient and often escape the attention of the physician.

The gall-bladder is attached to the under surface of the right lobe of the liver, hangs in a dependent position and empties above through the cystic duct. It always contains bile under variable tension and is never seen completely collapsed or empty. It has a rich blood supply from the cystic artery and from many small vessels in its attachment to the liver. The cut edge of the gall-bladder bleeds as freely as the incised intestine. Its abundant lymphatic supply has a free communication through its attachment to the liver, and with nodes in the hilus of the liver, at the juncture of the cystic and common ducts, along the common duct, and around the head of the pancreas and first portion of the duodenum. There are numerous lymphatic vessels in the wall of the gall-bladder and solitary lymph follicles have been seen in its mucosa.

The known functions of the gall-bladder have to do with the concentration and storage of bile, the secretion of mucus, and the regulation of pressure.

* Read before the Philadelphia Academy of Surgery, November 1, 1926, being record of work done in the section of Surgical Pathology of the Mayo Clinic of Rochester, Minn.

in the duct system. Its relations, if any, to digestion and to the metabolism of fat and cholesterol are not understood. No doubt more fluid leaves the gall-bladder by absorption through its wall than by way of the cystic duct. At operation it is often difficult and sometimes impossible to empty the distended gall-bladder by compression. The mere mechanical arrangement of the valves of Heister in the cystic duct does not adequately explain this fact and the likelihood of a sphincteric mechanism in the duct becomes more plausible. In operations under local anæsthesia the gall-bladder may be freely handled and compressed without causing much discomfort to the patient. Traction on the cystic duct causes pain and we have noted that under general anæsthesia traction on the gall-bladder preparatory to its removal sometimes caused reflex respiratory inhibition. The probable explanation of severe colic is strong muscle spasm in an inflamed gall-bladder or common duct when the outlet of either is obstructed.

Experimental cholecystitis has been produced by the injection of a large dose of a bacterial culture into the peripheral or portal circulation. That the gall-bladder is especially vulnerable to attack when the general circulation is loaded with infection is shown clinically in cases of typhoid fever and pneumonia. Direct introduction of bacteria into the lumen of the gall-bladder does not produce infection unless there is coincident obstruction. Rosenow produced cholecystitis by the intravenous injection of specific organisms and showed that the infection was interstitial. Mann produced, with regularity, a specific chemical cholecystitis by the intravenous injection of Dakin's solution and showed that the toxic agent, chlorine, reached the gall-bladder by way of the blood-vessels in its attachment to the liver. The reaction is practically confined to the gall-bladder, the ducts are not affected, the inflammation is intense and is caused by engorgement and rupture of the lymphatics with extravasation of blood. The mucosa is only slightly changed. The acute reaction which appears in from twelve to twenty-four hours may last for several weeks and after three months the gall-bladder may appear normal except for a few small white scars. Sometimes the condition becomes chronic.

The frequent association of hepatitis and cholecystitis is significant, but the evidence at hand does not warrant the conclusion that the usual route of infection is from the liver by way of the lymphatics. That the gall-bladder is often the primary seat of infection is indicated by the good results which follow cholecystectomy, by the fact that the portion of the liver adjacent to the gall-bladder is the area most frequently and characteristically affected in cholecystitis, and by the fact that marked hepatitis may exist with only slight inflammation of the gall-bladder and yet in severe cholecystitis the liver is often grossly normal. From experience in the operating room it would seem that cholecystitis is secondary to hepatitis in some instances, but primary infection of the gall-bladder with secondary hepatitis is more common. The importance of this conception is obvious from the standpoints of treatment and prognosis. The possibility of ascending infection in the wall of the common duct must be admitted, but there are few data on which

to base an opinion. Inflammatory reaction in the wall of the common duct was present in nearly all of a series of necropsy specimens from cases of cholecystitis. Since this reaction was most apparent in the region of the cystic duct juncture, it probably indicated extension from the gall-bladder. Pancreatitis when it affects the head of the gland or the triangle of infection is usually secondary to cholecystitis. There is ample clinical evidence of the relation between appendicitis and cholecystitis, especially in female patients. In many cases of duodenal ulcer there is also disease of the gall-bladder, which if not recognized and treated, may be the cause of post-operative symptoms.

Does the infected gall-bladder ever return to normal? It is probable that mild degrees of inflammation may undergo complete resolution, but cholecystitis when recognized clinically probably continues as persistent or recurrent inflammation with mild or severe exacerbations. The structural effects, derangement of function, and potential complications represent distinct liabilities when the damaged organ is allowed to remain. Gall-stones, especially when multiple, are most often a complication and result of cholecystitis. The single cholesterol stone, it may be granted, is a product of perverted metabolism. Practically all gall-stones are formed in the gall-bladder, only rarely do they originate within the intrahepatic ducts. Mild cholecystitis occurs with or without stones, but advanced chronic inflammation of the gall-bladder is nearly always accompanied by stones. The calculi sometimes form in crops and the same gall-bladder may contain several crops which vary in size, shape, and often in composition. The facets are caused by pressure and not by friction. The nuclei of stones often contain dead or living bacteria, and it has been shown that bacteria can penetrate a sterile gall-stone.

Will gall-stones dissolve in bile? Several varieties of gall-stones were placed in bottles to which were added bile obtained in some instances from the same gall-bladder as the stone and in other instances from foreign gall-bladders with and without stones. The bottles were sealed and kept at room temperature for one year without evidence that the gall-stones had dissolved.

Stones rarely originate in the common duct probably because its lumen is constantly flushed by bile. Stones enter the duct from the gall-bladder and cystic duct and if retained increase in size. The presence of a stone in the duct always causes more or less obstruction and inflammation, factors which favor the formation of stones. Therefore, it seems probable that some of the multiple stones found in the common duct were actually formed there.

The appearance of the gall-bladder *in situ* is peculiarly deceptive in its relation to clinical symptoms. Marked evidence of disease is often seen with only a few indefinite complaints, while a gall-bladder apparently normal in appearance but showing microscopic lesions may be the cause of repeated and severe attacks of pain and even jaundice. On what evidence do we base the diagnosis of disease of the gall-bladder when the abdomen is opened? There may be no gross indication of disease, and it is here that

experience has taught that if the clinical history is reliable and a verdict has been made against the gall-bladder, it should be removed. In these specimens there is always microscopic evidence of disease and the patients are relieved of their symptoms. Contributory signs in the diagnosis of cholecystitis are, the appearance of the liver, especially when that portion overlying the gall-bladder is gray, firm and contracted with radiating lines of fibrous tissue the result of hepatitis, changes in size of the glands along the cystic and common ducts, and the condition of the head of the pancreas. The appearance of the gall-bladder itself, except when grossly diseased, is not always reliable. The normal blue color may exist in the presence of infection and a deposit of fat beneath the serosa may or may not be indicative of disease. More can be learned by the sense of touch because when thickening and induration of the walls are detected there is likely to be inflammation. Small stones when present may be missed if the gall-bladder is distended and small ones in the cystic duct often escape detection. The presence of pericholecystic adhesions, whether to omentum, duodenum, or colon, is usually diagnostic of cholecystitis.

The material for this study was obtained from 112 consecutive cholecystectomies performed by surgeons at the Mayo Clinic. Within one or two minutes after the gall-bladder was removed its gross appearance was noted, it was then opened and the character of its interior and contents observed. Several sections were removed from the wall and immediately cut on the freezing microtome, stained and mounted. In the meantime the gall-bladder was studied under the dissecting microscope. Fresh material is particularly desirable for studying the gall-bladder because specimens obtained at necropsy are unsuitable for histologic study owing to the rapid changes which take place even within several hours after death. Much of the current opinion regarding the pathology of the gall-bladder is based on a study of necropsy specimens. Sixty per cent of the specimens contained stones, of which 22 per cent were single. The cystic duct contained stones in 11.6 per cent and in more than 15 per cent of the cases with stones in the gall-bladder they were also found in the cystic duct. The removal of stones from the cystic duct will usually require cholecystectomy, any other procedure aimed at saving the gall-bladder inflicts damaging traumatism on the cystic duct and invites the possibility of injury to the hepatic or common duct.

When stones are not present the thickness of the wall as determined by palpation is the most constant criterion of disease. The wall of the normal gall-bladder is thin, translucent, and, *in situ*, has a greenish-blue color imparted to it by the contained bile.

Bile becomes concentrated when it remains in the gall-bladder for even a short time. Inflammation may increase the secretion of mucus and in cases of obstruction forms the so-called white bile which is nearly always accompanied by stones. According to my observations, the bile in diseased gall-bladders is more often thick and concentrated than thin and watery, and sections from the wall usually show the lining epithelium intact unless the

organ is grossly destroyed. The concentrating power of the gall-bladder evidently is not much impaired in chronic cholecystitis.

The contracted fibrous gall-bladder contains stones in nearly every case or the stone has passed out into the common duct.

Papilloma of the gall-bladder, usually multiple, occurs as a small pale protuberance from the mucosa and was found in 35 per cent of the specimens. It cannot be detected until the gall-bladder has been opened and under the microscope appears as a simple elongated growth of mucosa. It is not malignant, but may be potentially so.

Hydrops of the gall-bladder is the result of intermittent obstruction usually by a single cholesterol stone, to which other stones may later be added. Complete obstruction causes atrophy of the gall-bladder. In hydrops the organ is distended, pale, and contains in addition to one or more stones watery mucus sometimes tinged with bile. The wall is markedly thickened and trabeculated. The microscope reveals loss of the villous appearance of the mucosa, low cuboidal or flat cells in place of the normal tall columnar epithelium of the mucosa, an increase in the number of goblet cells, proliferation of the glands of the mucosa and submucosa, oedema, congestion and inflammatory exudate in the wall, and always a marked increase in the amount of muscular tissue.

The "strawberry" gall-bladder, first described by Moynihan and MacCarty in 1910, derives its name from the speckled sulphur yellow appearance of the mucosa which in thin specimens is easily seen before the gall-bladder is removed. Sections stained by Sudan III reveal that the yellow appearance is caused by a substance which occurs in finely divided particles at the tips and bases of the columnar cells of the mucosa and in large cells of the submucosa. It is also said to occur in the walls of the blood-vessels of the gall-bladder. Chemically, it is a lipid material, an ester of cholesterol. The quantity of lipid varies in different specimens from amounts which almost fill the villi and give to the mucosa a brilliant yellow appearance to amounts so small that they can be detected only by the dissecting microscope or by special stains. The significance of the lipid substance is not known, but probably it has some relation to the metabolism of fat and cholesterol, and therefore, we cannot estimate its pathologic importance except to state that it does not occur in the normal gall-bladder. Twenty per cent of this series of specimens were "strawberry" gall-bladders, they all showed inflammatory lesions, and fifty per cent contained stones.

When the fresh gall-bladder is placed in water under the dissecting microscope one sees tall, delicate, interlacing folds enclosing polygonal spaces, and on the pellucid tips of these folds the fine blood-vessels can be traced. The arrangement of the mucosa provides an enormous surface area which makes possible the great absorptive power of the gall-bladder. The early changes in cholecystitis as oedema, congestion, hypertrophy, cholesterol deposit, papilloma, and ulceration can be detected in these folds of mucous membrane.

Microscopic sections through the wall reveal five layers, mucosa, sub-

mucosa, muscle, subserosa, and serosa or peritoneal covering. In my experience, the early lesions of chronic cholecystitis occur in the mucosa and submucosa and are characterized by congestion, oedema, and round-cell infiltration of the villi. The lining epithelium rarely desquamates. The results of experimental work show that infection may travel by the lymphatics from the liver to the outer coats of the gall-bladder, that hæmatogenous infection is usually interstitial, and that in chlorine cholecystitis the mucosal side is only slightly affected. However, the examination of specimens removed at operation showed that the mucosa and submucosa were the areas first involved. One rarely sees inflammation deep in the wall without involvement of the submucosa while the contrary is a common finding. The villi often elongate and interlace in a luxuriant fashion. They may be swollen and congested or they may have disappeared entirely, leaving a surface covered by flat epithelium or by hyaline fibrous tissue. The inflammation later extends through the wall of the viscus and becomes established in the deeper coats and in these specimens one can see that the inflammatory reaction diminishes from mucosa to serosa. The discrepancy between the clinical and experimental lesions may indicate that the pathway of infection is different.

In the submucosa of the normal gall-bladder are found clusters of mucous glands which were first described by Luschka in 1858. They are always present, but their number is greatly increased when the gall-bladder is diseased. They occur in two forms. In one they appear as simple clusters of mucous glands in the mucosa, submucosa, and sometimes deeper in the wall. In the other they lose their glandular appearance and show as deep crypts or diverticula which drop down through the mucosa and muscular layers and come to lie just beneath the serous covering of the gall-bladder. These crypts are lined by columnar epithelium similar to that covering the mucosa, they are in free communication with the interior of the gall-bladder and often contain bile. They sometimes fill with inspissated bile and become cystic, or they may be the birthplace of calculi in which case the condition spoken of as honeycomb gall-bladder is produced in which the stones seem buried in the wall. Many instances have been observed of crypts surrounded by a dense mass of small round cells and other signs of inflammation, so that the picture resembled a true intramural diverticulitis, and in such cases there were usually many adhesions to the gall-bladder. From these observations it seems likely that diverticulitis of the gall-bladder is the cause of pericholecystitis, that it represents the process by which slow perforation into neighboring viscera occurs with the formation of fistula, that rupture of one or more of these diverticula may explain many cases of bile peritonitis in which no gross opening in the biliary tract can be found. The glands and diverticula show a tendency to proliferate and become more numerous when stones are present in the gall-bladder so that it becomes necessary to distinguish this condition from carcinoma. In many cases where experimental cancer of the gall-bladder is said to have been produced by the introduction of foreign material,

the condition may not be cancer at all, but only a benign proliferation of these glands the result of foreign body irritation

The normal gall-bladder has a well-developed musculature which is made up of more or less isolated bundles arranged in two or more directions. No one has ever seen the human gall-bladder contract so that the muscle probably serves to maintain a condition of tonus. That the muscle by contraction acts to empty the gall-bladder of its contents seems to be established by the following observations. A characteristic feature of chronic cholecystitis is muscular hypertrophy which is especially notable when stones are present. The muscle bundles enlarge and may make up almost the entire thickness of the wall. The bundles may be separated by oedema and round-cell infiltration and sometimes they are split into fibres by inflammatory exudate. Frequently in specimens which contain stones, and especially if there has been obstruction and the presence of white bile, the gall-bladder when opened displays an appearance of trabeculation. This is characterized by the presence of ridges or bands which run and cross in several directions in a manner similar to trabeculation seen so commonly in chronic obstruction of the urinary bladder. In the latter instance it is well known that the trabeculated appearance is caused by hypertrophy of muscle bundles in the effort to empty the bladder against obstruction by stone, tumor, or stricture. In the interstices between the hypertrophied bundles small pockets or cellules are formed. Trabeculation of the gall-bladder is analogous in every way. Microscopic examination reveals that the bands are not made up of fibrous tissue, but represent large muscle bundles over which the mucosa is stretched, so that the villi or rugæ and most of the submucosa have disappeared, leaving a single layer of cuboidal or sometimes flat epithelium lying almost directly upon the muscular coat. At intervals, deep crypts may be seen penetrating between the muscle bundles. This hypertrophy should dispel any doubt of the importance and activity of the muscle of the gall-bladder whether in health or disease.

The subserous layer is made up of connective tissue, fat, lymphatics, and blood-vessels. The principal pathologic changes are congestion, oedema, and round-cell infiltration.

There were no specimens of acute cholecystitis in this series. Lesions of an acute nature as ulceration and free pus are more active stages of a chronic process. Gangrene, proven by microscopic examination, is very rare because of the rich and double source of blood supply, and when it does occur is usually the result of a diffuse infectious thrombosis of the main vessels in the wall of the gall-bladder. Acute cholecystitis is a clinical entity that is not often verified by the finding of acute lesions in the gall-bladder at operation.

Carcinoma was not found in any specimen. During the period when this study was made, four cases of carcinoma of the gall-bladder were encountered at operation, specimens were removed to confirm the diagnosis and in one case gall-stones were removed, but in all the condition was too far advanced for cholecystectomy. In a series of 10,126 gall-bladders removed at the Mayo

Clinic, 44 were reported adenocarcinoma, two epithelioma, and one lymphosarcoma. This does not represent the incidence of carcinoma because only rarely is a carcinomatous gall-bladder removed. In one instance adenocarcinoma and epithelioma were found in a removed gall-bladder. The patient was operated on again over two years later because of biliary obstruction, at which time there was no evidence of a common duct and a careful search, both gross and microscopic, failed to reveal carcinomatous tissue.

Stones are present in nearly 90 per cent of the malignant cases and this fact has led some to believe that they are the etiologic factor. The tumor grows into the liver and ducts by extension, but metastasis to distant parts is rare, probably because of the rapidly fatal issue from biliary obstruction.

CONCLUSIONS

The pathology of chronic cholecystitis has been studied in 112 surgical specimens by immediate examination in the gross and in frozen sections. The condition is usually not the result of an acute process, but it begins as a mild infection and inflammation of the mucosa and submucosa and progresses deeper into the wall of the viscus where it becomes established around glands, crypts and diverticula and between the muscle bundles. Its chronicity is fostered by the anatomic and histologic structure of the organ which favor stasis and obstruction. Attention is directed to the frequent presence of intramural diverticula and their relation to infection, stone formation, perforation, and pericholecystitis. The muscle of the gall-bladder plays an active part in its normal function and undergoes characteristic changes when the outlet of the viscus is intermittently or partially obstructed. Stones are often a complication of cholecystitis and usually an inevitable result of long-continued infection, but they may also form in the early stages of inflammation. Cholecystitis is usually a primary infection and cholecystectomy is a logical procedure because it removes the focus from which the attending and complicating lesions of cholecystitis derive their origin. Cases not relieved by cholecystectomy are probably instances of primary hepatic or pancreatic infection in which the gall-bladder has become secondarily involved, or the infection has so established itself that removal of the focus is without effect.

GALL-BLADDER TECHNIC

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It is not within the province of this paper to discuss cholecystostomy *versus* cholecystectomy, although it may not be amiss to voice an opinion in this regard. Of four hundred gall-bladder operations performed at the DeCourcy Clinic and followed every six months with follow-up circulars, it was found that

First—Recurrence of colic (stone) was much more frequent following cholecystostomy and was very unusual following cholecystectomy.

Second—Indigestion and flatus frequently persisted following gall-bladder drainage and disappeared in practically every instance following gall-bladder removal. This would argue that hepatitis, which is frequently present, disappears more rapidly following removal of an infected gall-bladder than

Third—Post-operative convalescence is more rapid and smoother following drainage

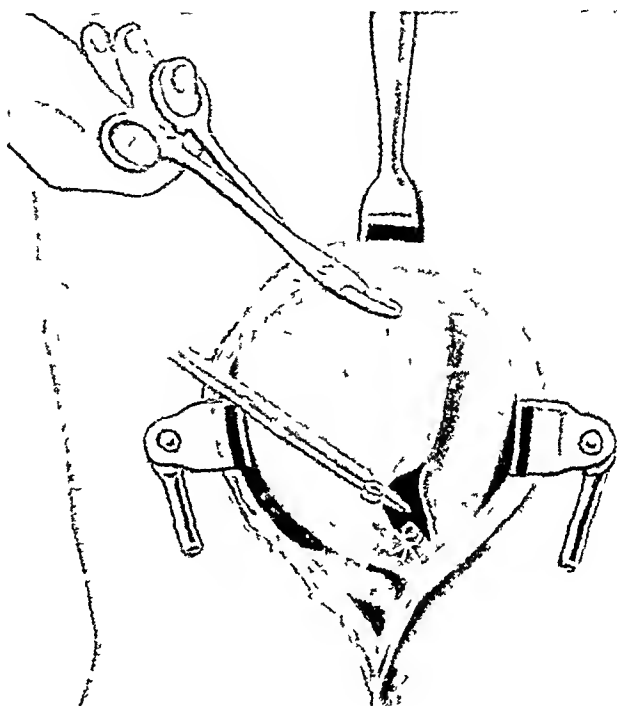


FIG. 1.—Eventration of liver by traction on gall-bladder for exposure of ducts

lowing cholecystectomy

Fourth—Preservation of bile is important. Prolonged deviation of bile from the intestinal canal, results in a distorted digestion, headaches, dehydration and so on.

Fifth—The immediate mortality is just as low following cholecystectomy as following cholecystostomy, with the possible exception of acute empyema, in which we still prefer drainage first with removal later.

In gall-bladder disorders the pathology is primarily in the gall-bladder. Hepatitis and duct involvement are usually secondary.

It is not at present known whether stones can form in the biliary ducts.

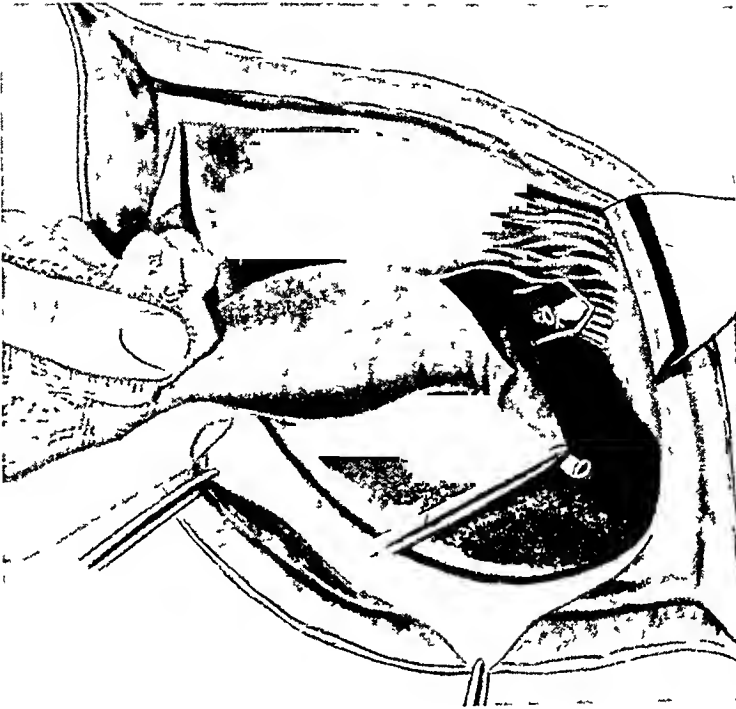


FIG 3—Enucleation of gall-bladder from below upward

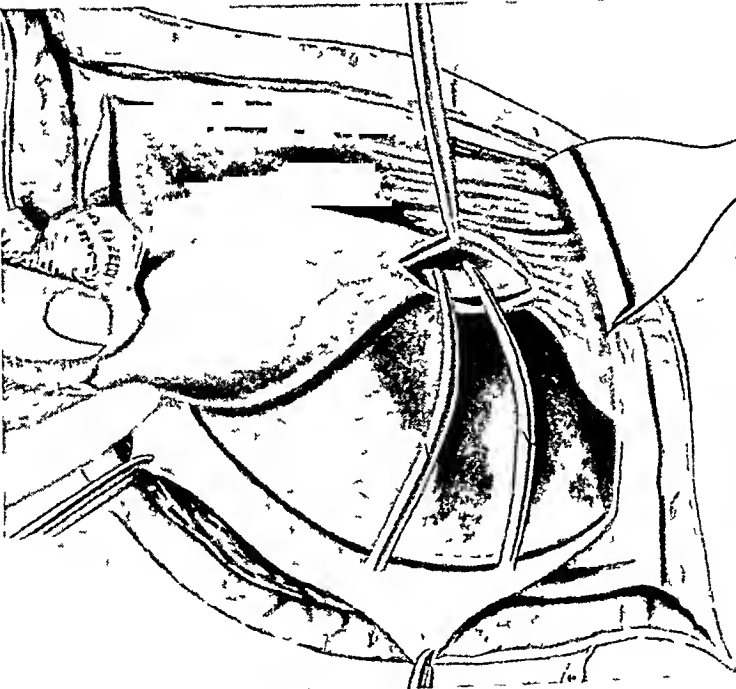


FIG 2—Clamping of cystic duct and artery

Stones have been found completely imbedded in the walls of the gall-bladder which could not possibly have been removed by drainage or curettement

From the pathological viewpoint it is therefore better surgery to remove the larger majority of diseased gall-bladders

Physiologically we may be wrong

Practically, however, we now know that persons are just as normal following the removal of their gall-bladders as they were before, and it is questionable in my mind whether a drained gall-bladder, formerly diseased, ever functions normally

From a technical viewpoint there still arises the question whether a gall-bladder should be removed from below upward or from above downward

For a number of years I removed all gall-bladders from above downward, feeling that I could accomplish this operation more readily than from below upward. After improving my technique, however, I soon began removing all from below upward and found this way to have the following advantages

First—The blood supply to the field of operation is controlled early in the operation, thus giving a field clear for dissection, thereby enabling us to avoid injury to common duct

Second—In removing a gall-bladder from above downward, infection and stones may be pushed into the ducts and may later escape our attention

Third—When removing from below upward, the gall-bladder can be used for traction, thus giving better exposure and in many cases giving us a field almost entirely out of the abdominal cavity

Fourth—In removing from above downward, the incision was usually



FIG 4 —Raw surfaces sutured over with peritoneum

carried down to the muscular coat of the gall-bladder and the stripping continued in this plane

From recent experiments we have found that the infection frequently penetrates the peritoneal covering of the gall-bladder and unless this is removed, some of the infection may remain. This is further enhanced by the fact that we almost always find adhesions of surrounding structures to the gall-bladder when diseased.

Our operation consists of a longitudinal incision, slightly inside the outer border and extending from the costal margin to below the umbilicus. A self-retaining retractor is then introduced with another hand retractor following upward under the costal margin.

The gall-bladder is next explored with the surrounding structure, stomach, pancreas, etc., but is not opened.

If removal is decided upon, the gall-bladder rest under the patient is elevated about four inches (We have also occasionally placed the patient in a reversed Trendelenburg posture but have not made it a routine.) Back rest is usually sufficient.

The gall-bladder is next grasped with a small Kelly forceps. A forceps with teeth cannot be used. With traction the gall-bladder is pulled outward and upward, bringing the liver with it. This can be accomplished in at least nine out of every ten cases. Occasionally we find a gall-bladder so friable or so distended that this cannot be accomplished. In these cases sufficient traction can usually be made with the hand.

After elevating the gall-bladder the cystic duct is exposed and isolated with blunt dissection. The tissues surrounding the cystic duct are usually very friable and can be easily separated from the duct with the aid of a hæmostat, entering the tissues and there separating the blades. The duct should be entirely isolated from all surrounding structures before it is tied. We have found that since we are doing this that we do not have any

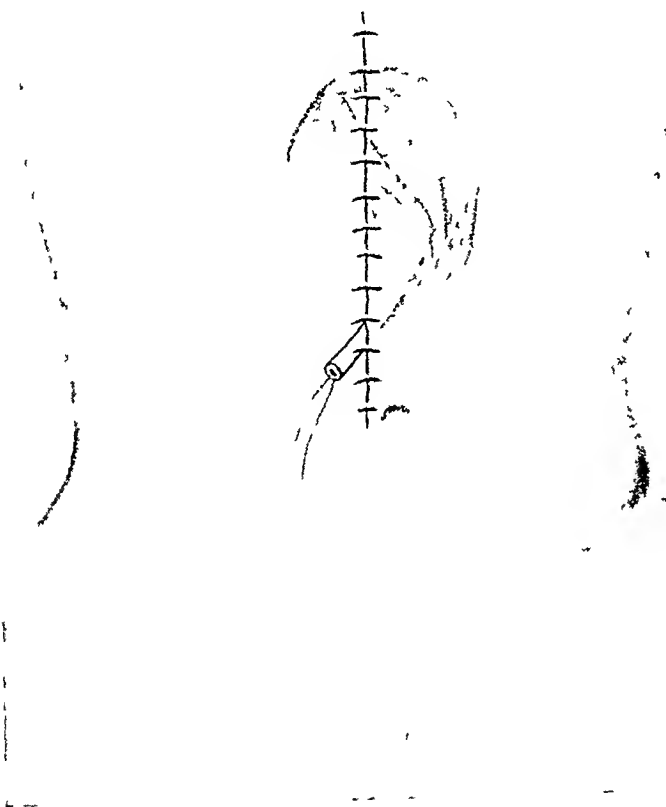


FIG 5 —Finished operation with tube to cystic duct

drainage later. If fat, etc., is included in the ligature, drainage usually occurs. The duct is tied with number three chromic gut and the ends of suture left long.

The cystic artery is next grasped and ligated and allowed to drop into the wound.

The gall-bladder is then stripped upward with sharp dissection, leaving a little peritoneum on either side and suturing these over the raw surfaces of the liver as the gall-bladder is removed.

A quarter-inch tube is now passed over the catgut on the cystic duct and passed down lightly to the duct. This tube is not anchored to the abdominal wall.

The abdominal incision is now closed.

If one observes closely, it will be seen that the cystic duct enters the common duct from the back, rather than into the anterior or side portion, as we would suspect. One must be very careful therefore not to injure the common duct. This is best accomplished by blunt dissection and complete isolation of the cystic duct. I believe that when the duct is injured it is usually done so by blind grasping with forceps and ligation *en masse*.

The sutures on the cystic duct are allowed to protrude from the abdominal wound so that if symptoms of common duct obstruction occur, due to inflammatory swelling or overlooked stone, they may be followed down and the duct easily opened.

ULCER OF MECKEL'S DIVERTICULUM AS A CAUSE OF INTESTINAL HEMORRHAGE

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FROM THE JACKSON CLINIC

MECKEL'S diverticulum is responsible for many serious and frequently unrecognized abdominal complications. The literature contains too many reports from the autopsy room. With increasing knowledge on the part of the general practitioners of the possible surgical complications that may arise from this embryologic anomaly, there should result a marked reduction in the mortality rate in these cases. Heretofore a diagnosis has often been made too late for successful surgical intervention. Among the various pathologic conditions that may occur in Meckel's diverticulum are intestinal obstruction, intussusception and volvulus, diverticulitis, ulceration tending to perforation with peritonitis, fistulas, suppuration, gangrene, hernia, cysts, tumors (benign and malignant), tuberculosis and hemorrhage. It is with hemorrhage that this report is concerned.

Judging from the literature, hemorrhage from Meckel's diverticulum is a rare complication, and as shown by the chart, only eight cases were found. The fact, however, that two patients with this condition were referred to the Jackson Clinic by the same physician within a decade, leads to the assumption that many more cases have occurred, and were either not recognized or not reported. The clinical symptoms so closely paralleled each other in these two cases as to enable the family physician, Dr E A Ketterer, of Montfort, Wis., to make a correct tentative diagnosis in the second patient. The history and findings in the latter case were so similar to the published report of the first patient that we were led to concur with the physician's opinion. It is rather remarkable that this correct pre-operative diagnosis, the first of its kind to be reported, should have been made in a farm house by a so-called "country doctor." The history and findings were as follows:

M O., a boy aged fourteen years, was seized with severe generalized abdominal cramps following the eating of green apples four days previous. A physician was called and diagnosed the condition as green apple colic. The boy was relieved of the pain with sedatives, but became progressively weaker. On the third day considerable bright blood containing many clots was passed from the rectum. At no time did vomiting occur. Another physician, Dr E A Ketterer, was called. He observed the further passage of several pints of blood varying in color from maroon to bright red. Noticing the marked anemia, progressive weakness, and absence of general physical signs, except slight tenderness in the right lower quadrant, he was vividly reminded of the clinical picture of a similar case,[†] and made a diagnosis of intestinal hemorrhage from Meckel's diverticulum.

* Presented at the Annual Alumni Meeting of the Mayo Foundation, October 6, 7, 8, 1926, Rochester, Minn.

† The former patient was operated upon and the findings reported by Dr R. H. Jackson. The article appeared in the *ANNALS OF SURGERY* and was the first report of such a case that we found in the literature of this country.

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Several hours later Dr J Hurlbut and I saw the boy. Temporary measures had been used to improve the general condition, but the hemorrhages had continued and we were shown several vessels full of blood. The physician reported an improvement in the pulse, which now was 120 and of poor quality. The boy appeared extremely anæmic, was very weak, and showed an anxious, rather pinched facies. He responded freely to questions, but was nervous and restless. Except for the anæmia and dryness of the tongue and skin, the general physical examination was negative, save for a slight tenderness in the right lower quadrant. The blood-pressure showed 124-50. Heart sounds were fair. The question of keeping the patient at the farm house with only meagre facilities or of transporting him to a hospital ended in the latter decision. Less than an hour remained in which to improve his condition and to transport him several miles over a hilly country to catch the daily train. Five hundred cc of glucose and five units of insulin were given intravenously. In our experience this is an excellent temporary restorative in cases of severe shock or hemorrhage. A slight reaction was followed by a steady improvement, and against the father's wishes, who felt that the boy would not survive, the trip was started. On reaching town ahead of the train it was decided to continue by auto the remaining sixty miles.

We believed that the saving of time was of more importance than the added risk of jolting. At the end of the journey the patient was taken at once to the Clinic, where his blood was grouped and a count made. The hæmoglobin was 12 per cent, and red blood-cells 1,210,000, blood group IV. A blood transfusion by the citrate method was given immediately at the hospital by Doctor Hurlbut. The boy went into complete collapse, the pulse being scarcely perceptible. The usual emergency methods were used, but the best response was obtained from the use of glucose-insulin intravenously, following the transfusion of the 500 cc of blood. The patient remained in a semi-conscious state for two hours, and then slowly improved. Mild delirium followed the administration of whiskey, but sleep was induced by morphine. Fibrinogen was given subcutaneously and orally in maximum doses, and was continued for four days. The following day the blood picture was slightly improved as shown by the chart, and another blood transfusion was given. This was followed by a third transfusion during the week until the hæmoglobin registered 70 per cent, and the red blood-cells 2,620,000. The general condition steadily improved so that he was able to be up and around at the end of a week. The gastro-intestinal tract was kept at absolute rest for three days, and after the first twenty-four hours no further intestinal hemorrhages were observed. The advisability of a roentgenological study was considered, but was not made for fear of starting the hemorrhage anew. Digital rectal examination was negative.

Operation—A subumbilical right rectus incision was made, and a small amount of

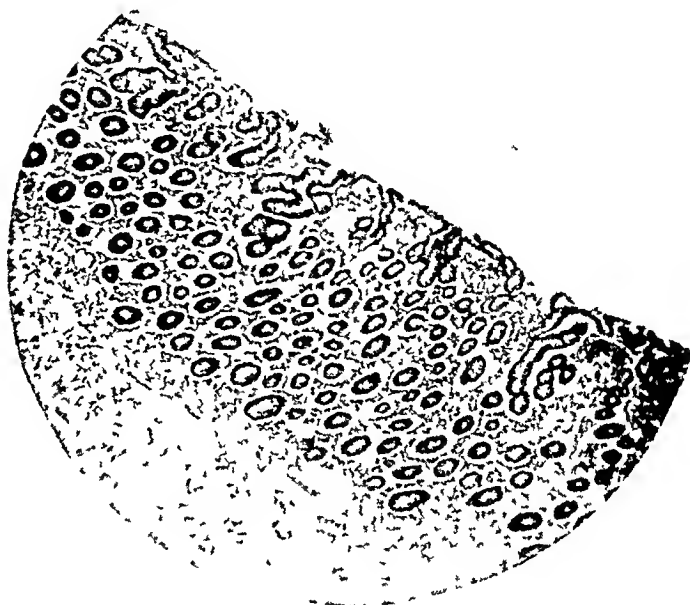


FIG 1—Area of aberrant gastric mucosa showing typical gastric glands

straw-colored fluid in the abdominal cavity allowed to escape. The terminal ileum was located and about 40 cm above the cæcum was found a Meckel's diverticulum 3 by 8 cm. The distal end was free and there was no visible or palpable evidence of hemorrhage. Branches of the omphalo-mesenteric artery were distended and these were separately ligated. A further search of the other abdominal viscera revealed no pathological lesions with the exception of the appendix, which contained several fecal concretions and was slightly swollen. Appendectomy was performed. Rubber-covered clamps were then applied to the ileum above and below the diverticulum to guard against soiling. The diverticulum was excised by means of an elliptic incision, the axis of which was

made transverse in order not to reduce the lumen of the bowel in suturing. The margins of the incision were closed by a through and through suture of dulox. This was reinforced by several stay sutures of silk. As the base of the walls of the diverticulum at its junction with the ileum were not indurated, a simple excision was sufficient. When marked induration exists at this point, a resection of the adjacent section of the ileum may be advisable, as was done by R. H. Jackson in his case.

Convalescence was uneventful and the case was discharged from the hospital on the tenth day. One month later the patient returned for observation and presented an



FIG 2 —Characteristic gastric mucosa adjacent to area shown in Fig 1

entirely different picture. He had gained ten pounds in weight and was rosy-checked. The blood count as seen from the chart was normal.

The chief point of interest in the pathology of hemorrhagic ulcer of Meckel's diverticulum concerns the presence in the affected diverticulum of areas of aberrant gastric mucosa with pyloric, Brunner's, and fundus glands (Stulz and Woringer). The histological picture of the ulcer is that of gastric or duodenal ulcer, or better still, that of peptic ulcer of jejunum following gastro-enterostomy (Hubschmann). It is enough to say that Meckel's diverticulum, whether with a total or only a partial coating of gastric mucosa, can and does behave like a miniature stomach (Guibal).

Stulz and Woringer point out that there is a definite analogy between the peptic ulcer as seen in Meckel's diverticulum, and that of the stomach, and that a further study of the former may throw some light on the origin of peptic ulcer in general.

Examination of this specimen at the time of operation revealed a puckering near the distal end (as seen in the photograph) that resembled a small ulcer. The pathological examination, as made by Dr C. H. Bunting, showed

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the presence of the characteristic areas of gastric mucosa, and an area of ulceration

Review of the Literature—A study of the cases heretofore reported of ulcer of Meckel's diverticulum in which hemorrhage is the predominate symptom reveals the following. Of the eight cases three have been reported in this country and the others abroad. Seven of the patients have been males. With the exception of one case, hemorrhage has occurred either in infancy or childhood in every instance. Our patient may be said to be the only acute case, the others being characterized by severe hemorrhages followed by periods of remission. The outstanding symptom is the frequent repetition of profuse intestinal hemorrhages. The blood may be either bright red or maroon or tarry. Clots may be present, but mucus as seen in dysentery or intussusception is absent. Excision or resection of the diverticulum stopped the hemorrhages and affected a cure in every case. Pain may or may not be present. Colics appeared in several cases. Abdominal examination is usually negative.



FIG 3—Area of ulceration. The base of the ulcer is made up of a layer of connective tissue infiltrated with polymorphonuclear leucocytes and lymphocytes. Some gastric glands appear at the edge of the ulcer.

The literature contains reports of several more cases of ulcer of Meckel's diverticulum in which hemorrhage occurred, but in which the main picture was one of perforation with peritonitis. Stulz and Woringer have recently published an excellent summary of these cases. We have observed or know of other cases of this type, but in these, surgery was indicated for the relief of perforation and not hemorrhage.

NOTE—Callendar, G. R. *Am J M Sc*, July, 1915. The autopsy report of a child who had died from intestinal hemorrhage is given. An ulcer of the ileum extending to the border of a Meckel's diverticulum was found. Gastric glands were present in the diverticulum. No clinical history was given. Another case in which we were unable to trace the record is that of Griffith as quoted by Abt and Strauss.

NOTE—At the 1926 meeting of the American Medical Association in the discussion following the paper of Doctors Abt and Strauss on this subject, the following physicians reported having observed cases: Dr. C. V. Moore, Portland, and Dr. J. B. Stone, Richmond. The cases of Doctors Neff and Schultz did not directly pertain to the subject of this paper inasmuch as the complications of perforation and intussusception occurred.

In considering the differential diagnosis it may be necessary to rule out intussusception. In this condition only a small amount of blood is passed, and symptoms of intestinal obstruction may be present. A mass may usually be palpated abdominally or by rectum. Pain recurs paroxysmally every few minutes. Vomiting is first of the contents of the stomach and later bilious. The chronic type of hemorrhagic ulcer of Meckel's diverticulum offers more of a diagnostic problem. Both conditions may occur during infancy, although the youngest patient with hemorrhagic ulcer was nearly a year old. In both instances the male sex is most often affected.

In conclusion, I believe that it is well to point out that this unusual condition is probably not as rare as has been generally supposed. That in any case of severe intestinal hemorrhage, especially it occurring in young boys, a hemorrhagic ulcer of Meckel's diverticulum should be suspected. As pointed out by other writers, delay in cases of ulcer of this kind may lead to perforation with peritonitis. We feel fortunate in having had the facilities to build up our patient to a condition in which operation was performed with comparative safety.

TABLE I

Reported Cases of Hemorrhagic Ulcer of Meckel's Diverticulum

Date	Age	Sex	Duration	Symptoms	Treatment	Result	Author
1903	18	M	14 yrs	Bloody stools Pain rt l q	Resection of Diverticulum	Recovery	Hilgenreimer
1922	28	M	24 yrs	Bloody stools Abdominal pain	Resection of Diverticulum	Cured	Megevaud Dunant
1924	10	M	4 yrs	Bloody stools Colic pains left l q—vomiting	Resection of Diverticulum and 12 cm of ileum	Cured	Jackson, R. H
1924	14	M	6 mos	Bloody stools	Excision of Diverticulum	Recovery	Guibal
1925	41	M		Bloody and Purulent stools Abdominal colic	Excision	Cured	Pascale
1926	11 mos	M	2 mos	Bloody stools Fever—vomiting	Resection of	Recovery	Abt and Strauss
1926	2	F	4 mos	Tarry stools Abdominal cramps	Resection of Diverticulum	Recovery	Abt and Strauss
1926	11	M	2 mos	Black stools	Resection of Diverticulum	Recovery	Abt and Strauss
1926	14	M	6 days	Bloody stools Abdominal colic	Resection of Diverticulum	Cured	Jackson, A S

BIBLIOGRAPHY

- Hilgenreimer *Beitrage z klin Chirurgie*, 1903, vol xl, pp 99-135
 Jackson, R. H. *ANNALS OF SURGERY*, 1924, vol lxxx, pp 222-224
 Megevaud et Dunant *Revue de Chirurgie*, 1922, vol lx, pp 536-552
 Guibal *Bull et Mem de la Soc de Chirurgie de Paris*, 1924, vol l, pp 349-355
 Pascale *La Reforma Medica*, August 3, 1925, pp 721-724
 Stulz and Woringer *ANNALS OF SURGERY*, 1926, vol lxxviii, pp 470-478
 Abt and Strauss *The J A M A*, September 25, 1926, vol lxxvii, No 13, pp 991-996

CHILLS IN ACUTE APPENDICITIS *

AN ANALYSIS OF 2841 CASES OF ACUTE APPENDICITIS TREATED IN MT SINAI
HOSPITAL OF NEW YORK CITY

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THAT the death rate in acute appendicitis has been materially lowered in the past decade is definitely established. Still it is far from inconsequential. Recent papers on the subject by Deaver and Magoun,¹ Gatch and Durman,² strongly emphasize that this particular surgical problem is not yet solved. While the clinical side has been studied quite carefully, certain symptoms remain which will bear more thorough investigation. The incidence and significance of chills is still obscure. It is of extreme importance to inquire routinely concerning this symptom in all cases, for it has more than an academic value. A review of what the various authorities have written on this subject will be of interest.

Gerster³ stated, "the occurrence of a chill is of gravest import and should be considered to constitute a more urgent indication to operate than even the signs of local peritonitis." Deaver⁴ writes, "chills are a rather uncommon occurrence in appendicitis, yet if at the onset of the attack they occur in rapid succession, and are accompanied by a temperature, they indicate a rapidly developing gangrene of the appendix. The opinion commonly entertained that the development of a peri-appendicular abscess is attended with chills is fallacious. Chills occurring on the second or third day of the attack and associated with high fever, sweating, a cold, clammy skin, indicate the development of metastatic or embolic abscesses. In neurotic patients a chill may be experienced and be of no moment." Fowler⁵ says, "the occurrence of a chill in the first stages of the disease is only occasionally noted, even in cases of more than usual severity. In certain cases it marks the occurrence of suppuration. Neither the severity of the primary attack nor the gravity of the subsequent lesions seem to bear more than a casual relation to the occurrence of the pronounced character of this symptom." According to Kelly and Hurdon,⁶ "chills are exceptional in cases of simple diffuse inflammation but are not rare with severe lesions. Of the cases of acute appendicitis not associated with abscess or general peritonitis admitted to the Johns Hopkins Hospital, 15 per cent of them gave a history of chills and in all of these, with the exception of two, the appendix was gangrenous or perforated or distended with pus. In the two cases showing slight lesions there were merely chilly sensations, which in one were probably accounted for by the presence of oxyuriasis, associated with high temperature. In three cases the chills occurred at the onset. In one the patient who had gone to

* Read before the Surgical Section at New York Academy of Medicine, December 3, 1926

bed well, was awakened with a severe chill. More frequently the chill occurred several hours or a day or two after the onset. But 50 per cent of the cases of diffuse or generalized peritonitis were accompanied by chills occurring in some instances at the onset of appendicitis, in others with the beginning of the symptoms of peritonitis. A limited number of the cases associated with circumscribed abscess gave a history of chills, sometimes occurring at the onset or again after the third or fourth day. Repeated chills occurring late in the course of the malady generally indicate a dissemination of a pyæmic process." Binnie⁷ states, "chills are occasionally present in early appendicitis and usually indicate serious damage to the appendix. Repeated chills are strongly indicative of the infection of new areas or of pyæmia."

TABLE I
Classification of Acute Appendicitis and Mortality Percentages

	Number	Mortality per cent
Total number of cases of acute appendicitis (1916-1925)	2841	5.2
Total number of cases of acute catarrhal appendicitis	842	9.5
Total number of cases of acute gangrenous appendicitis	975	3.1
Total number of cases of acute appendicitis with abscess	665	5.4
Total number of cases of acute appendicitis with general peritonitis	359	20.0

Quoting from *Osler's Modern Medicine*,⁸ "Chills are sometimes met with at the onset and at various times throughout the course. A considerable proportion of cases begin with rigors and a sense of general coldness after which nausea and other symptoms set in. The chills usually cease after the disease is fairly established and there is no tendency to recurrence until extension of the infected process has caused invasion of the peritoneum. In peri-appendicular abscess regularly or irregularly recurrent chills may continue for a long time. Still more marked is the tendency to chills accompanying widespread infection and in instances of pylephlebitis."

Several of these statements are obviously contradictory. In order to ascertain the occurrence and significance of chills, the histories of 2841 cases of acute appendicitis entering the wards of the Mt Sinai Hospital, New York, from 1916 to 1925 inclusive, were reviewed. Of these, 836, 29 per cent, were classified as acute catarrhal inflammation, 976, 34 per cent, were grouped in the gangrenous variety, 670, 23 per cent, were complicated by abscess formation, and 359, 13 per cent, were acute appendicitis with general peritonitis. The mortality of this series was 5.2 per cent, a mortality of 9.5 per cent in acute appendicitis, 3.1 per cent in gangrenous appendicitis, 5.4 per cent in acute appendicitis with abscess, and 20 per cent for appendicitis with general peritonitis. (TABLE I)

The exact physiological mechanism of a chill is still obscure. It is known to occur at the onset of certain acute infectious diseases and apparently bears some relationship to venous thromboses. It is not definitely proven that an acute appendicitis can be placed in this latter category, although it probably

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can In this series, 192 patients gave a history of having had a real, shaking chill, and 206 complained of chilly sensations. In other words, chill, as a clinical symptom before operation occurred in about 68 per cent of all cases.

It is extremely interesting to note that cases of acute catarrhal appendicitis developed a chill in 66 per cent of their number, those with frank gangrene in 67 per cent, those with peritoneal abscess in 67 per cent, and those with a general diffuse peritonitis in 69 per cent (Table II).

TABLE II
Incidence of Chills and Mortality Percentage

	Number	Per cent	Mortality per cent
Total number of cases of acute appendicitis with chills	192	68	68
Total number of cases of acute catarrhal appendicitis with chills	50	66	2
Total number of cases of acute gangrenous appendicitis with chills	67	67	91
Total number of cases of acute appendicitis with abscess with chills	50	67	61
Total number of cases of acute appendicitis with peritonitis with chills	25	69	8

From these figures it appears that chills occur in about the same proportion regardless of the pathology at the time of operation. In other words, the degree and extent of the gross pathology seems to have little influence or to bear any relationship to the occurrence of chills within the first forty-eight hours, and as a rule this symptom is not an index of the severity of the disease, or the extent of the pathological process. It seems reasonable to suppose that the mechanism underlying this phenomenon is associated with tissue changes occurring early in the course of an acute appendicitis. This is further attested by the fact that 74 per cent of the cases of acute appendicitis, 54 per cent of the gangrenous appendices, 51 per cent of the cases of

TABLE III (a)
Time of Occurrence of Chill

Diagnosis	Hours				
	1-12	13-24	25-48	49 or later	Not stated
Acute catarrhal appendicitis	74%	18%	6%	0	2%
	92%				
Acute gangrenous appendicitis	54%	22%	15%	1%	8%
	76%				
Acute appendicitis with abscess	51%	16%	10%	18%	5%
	67%				
Acute appendicitis with general peritonitis	55%	15%	8%	10%	12%
	70%				

abscess and 55 per cent of those with general peritonitis had their chill within the first twelve hours after the onset of symptoms. Seventy per cent of all rigors occurred within the first twenty-four hours (Table IIIa). A primary chill on the third day, or even later in the course of the disease, seemed

TABLE III (b)
Time of Operation

Diagnosis	Hours				
	1-12	13-24	25-48	49-72	73 or later
Acute catarrhal appendicitis	48%		30%	10%	12%
Acute gangrenous appendicitis	41%		15%	15%	25%
Acute appendicitis with abscess	20%		24%	15%	31%
Acute appendicitis with general peritonitis	20%		44%	4%	32%

associated with abscess formation, and the delayed occurrence occasionally heralded the onset of a general peritonitis (Table IIIa).

Whether the incidence of chills alters the prognosis, or whether cases presenting them are more liable to post-operative complications, especially pylephlebitis, are two very interesting and important problems. The combined mortality of cases with chills was 6 per cent, the death rate of those without was 51 per cent. At first glance, it appears that chills increase mortality figures only slightly. On closer analysis, however, the association of chills with certain types of pathological lesions appears to possess special significance. This is truest in cases of gangrene of the appendix with chills, in which the mortality apparently increases from 2.6 per cent to 9 per

TABLE IV
Cases Without Chills and Mortality Percentage

	Number	Mortality per cent
Total number of cases of acute appendicitis without chills	2649	51
Total number of cases of acute catarrhal appendicitis without chills	786	18
Total number of cases of acute gangrenous appendicitis without chills	909	2.6
Total number of cases of acute appendicitis with abscess without chills	620	5.3
Total number of cases of acute appendicitis with peritonitis without chills	334	21

cent (Tables II and IV). The cause of death in four of these six patients was attributable directly to pylephlebitis.

Pylephlebitis, in the minds of most surgeons, seems to have been relegated to the frequent complications of appendicitis which have occurred in the past. In this series it occurred in nine cases, or 3 per cent (see Table V), and yet, of those cases which terminated fatally, 61.1 per cent succumbed to this com-

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plication Almost 5 per cent of cases with chills subsequently developed pylephlebitis, and of these, 88 per cent gave a history of ante-operative chills While it must be granted that this untoward complication occurs in an exceedingly small percentage, nevertheless, a complication which directly or indirectly accounts for more than 5 per cent of deaths is serious Petren,⁹ in a collected series of 1340 autopsies in acute appendicitis, found liver abscess, a result of suppurative phlebitis, responsible for 5 per cent of all deaths Whenever a history of chills is obtained, pylephlebitis as a potential complication should be borne in mind Thalheimer¹⁰ goes a step further and remarks, "every case of acute appendicitis should be considered as a potential

TABLE V
Incidents of Pylephlebitis in Cases with Ante-operative Chills

	Number	Pylephlebitis
Total number of cases of acute catarrhal appendicitis	50	1
Total number of cases of acute gangrenous appendicitis	67 ¹	4
Total number of cases of acute appendicitis with abscess	50	2
Total number of cases of acute appendicitis with general peritonitis	25 *	0

* Two of these cases developed pylephlebitis with post-operative chills

one of early pylephlebitis, whether there is a history of chills or not Consequently, the appendix and its neighborhood should always be carefully inspected (at operation) for the presence of small thrombosed veins, so that these can be dealt with " However, there are innumerable cases with marked venous thromboses of the mesentery, in which an uneventful recovery ensues following appendicectomy Besides, Sonnenberg¹¹ believes that most acutely and chronically inflamed appendices have thromboses, and according to Lenhartz,¹² the prompt ablation of the primary bacterial focus, i e, the appendix, and the ability of the liver to destroy numbers of bacterial emboli are the reasons that portal pylephlebitis is not more common It does not seem justifiable to excise the thrombosed veins of the ileo-cæcal angle, as advised by Wilms,¹³ as a prophylactic measure to prevent pylephlebitis Experience has shown that not only is it almost impossible to excise this entire network, but also that this procedure is dangerous Sprengel¹⁴ reported a case in which following this procedure, a cæcal fecal fistula developed which autopsy proved to be due to insufficient blood supply

In 181 cases, in which a single chill was recorded, seven died (two from pylephlebitis) a mortality of 3.7 per cent In other words, the mortality of cases with a single ante-operative chill was no higher than that for all cases without chill It is more than likely that the death rate would have been greater had this radical procedure of incision or excision of the thrombosed veins of the ileo-cæcal angle been performed routinely If there is definite evidence of suppuration in the mesenteric radicles, or the ileo-colic vein is felt as a thrombosed cord, some procedure is certainly justified to prevent the spread of venous infection

In eleven cases in which chills were multiple before operation, five died,

four of these from pylephlebitis. Pylephlebitis in patients with multiple chills is almost a foregone conclusion, and certainly in those cases a ligation, or resection of the ileo-colic vein, if thrombosed, as advocated by Braun,^{1*} should be done always as a routine procedure, preferably before the actual appendectomy. A detailed study of the treatment of pylephlebitis of appendicular origin has been considered more fully in a recent communication.¹⁶

The occurrence of post-operative chills, especially when none have been noted before, is extremely rare. In this series of 2841 cases, it happened only three times. Two of these developed fatal suppurative phlebitis of the portal vein and in one there was no explanation for the single chill which occurred.

CONCLUSIONS

1. A history of chills should be inquired from all patients suffering from acute appendicitis.

2. The presence of a chill in the first forty-eight hours is no index of the severity of the disease nor the extent of its pathology.

3. A primary chill on the third day or later, seems associated with abscess formation or the onset of a general peritonitis.

4. When a chill is present, especially in gangrenous appendicitis, the possibility of pylephlebitis should constantly be borne in mind and the appendicular mesentery should be carefully investigated for evidence of suppurative phlebitis.

5. When chills are multiple a routine ligation or resection of the ileo-colic vein should be done, preferably before the actual appendectomy.

6. Post-operative chills are invariably due to suppurative pylephlebitis.

The author wishes to express his thanks to Dr. E. Beer, Dr. A. A. Berg, Dr. C. Elsberg, Dr. H. Lihenthal, and Dr. A. V. Moschcowitz for permission to study the cases of acute appendicitis which have occurred on their respective services.

REFERENCES

- ¹ Deaver and Magoun. *ANNALS OF SURGERY*, 1924, June, vol. lxxix, p. 854.
- ² Gatch and Durman. *ANNALS OF SURGERY*, 1924, June, vol. lxxix, p. 862.
- ³ Gerster. *Trans. of the American Surgical Assn.*, 1903.
- ⁴ Deaver. *Appendicitis*, 3rd Ed., Blakiston, 1905.
- ⁵ Fowler. *Appendicitis*, 2nd Ed., Phil., Lippincott, 1900, p. 54.
- ⁶ Kelly and Hurdon. *Vermiform Appendix and its Diseases*, Phil., Saunders and Co., 1905.
- ⁷ Binnie. *Ochsner Surgical Diagnosis and Treatment*, Phil., Lea and Febiger, 1921, vol. xix, p. 719.
- ⁸ Osler's *Modern Medicine*. Lea and Febiger, vol. iii, p. 309.
- ⁹ Petren. *Bruns Beiträge*, 1914, Bd. xciv, Heft 2, S. 314.
- ¹⁰ Thalheimer. *Arch. of Surg.*, March, 1924, vol. viii, p. 658.
- ¹¹ Sonnenberg. *Pathologie und Therapie der Perityphlitis*, Leipzig, 7. Heft, 1913.
- ¹² Lenhartz. *H. Nothnagel, Spezielle Pathologie und Therapie*, Bd. iii, S. 366.
- ¹³ Wilms. *Zentralblatt für Chir.*, 1909, Bd. xxxvi, S. 1041.
- ¹⁴ Sprengel. *Zentralblatt für Chir.*, 1911, No. 2.
- ¹⁵ Braun. *Bruns Beiträge*, 1913, Bd. lxxxvi, Heft 2, S. 314.
- ¹⁶ Colp. *Surg., Gyn. and Obst.*, Nov., 1926, vol. lxi, No. 5.

TRAUMATIC APPENDICITIS

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MOOREHEAD, in his book on "Traumatic Surgery," states "It seems highly improbable that any sort of violence could produce a lesion of such deep-seated, movable and well-protected tiny piece of intestine as is the appendix, and yet do no damage to surrounding intestine nearer the source of violence and far more vulnerable"

In view of this statement let us first consider the anatomic fact, that the appendix is not always as freely movable as Doctor Moorehead would have us believe. Very frequently it is changed by past diseases so that either the walls are sclerosed by a prior inflammation or an inflammatory process had spread into the meso-appendix, so that it became thick and unyielding. As a consequence of this thickening the free border of the meso-appendix is shortened and the appendix is curved on itself or is slightly angulated, so that in the latter instance, when the intra-luminary pressure in the appendix is increased, the mucosa is stretched and a tear may occur with extravasation of some of the intestinal contents (feces with associated bacteria) into the submucous layer and there is produced either a progressive and active or a slumbering inflammation.

The intra-luminary appendicular pressure may be increased by any force which decreases the intra-abdominal space. This force, however, must be suddenly exerted, for instance, a squeeze of the abdomen not severe enough to bring about a rupture of a viscus or a sudden blow upon the abdomen (the blow not necessarily being over the area of the appendix). The force must be of sufficient violence to produce a rupture of the mucosa with resulting infiltration and inflammation. If the blow is over the appendix and the abdominal muscles are caught in a state of relaxation, even a bruising of the appendix might possibly occur. However, what most likely takes place is that by the blow, the abdominal muscles are thrown into a state of violent contraction and press forcibly upon the intestinal viscera.

If the colon and cæcum are filled with fecal matter or with gas, the lumen of the appendix is forced open and some of the contents of the cæcum are pushed in. If there is a constriction of the lumen of the appendix, the mucosa is torn and if in addition an enterolith is present, the rebound of the fecal mass from the increased intra-luminary pressure may close the opening entirely. An accumulation of fluid occurs in the lumen. The increase of the intra-luminary pressure causes pressure on the veins, so that congestion and œdema of the walls of the appendix follow. The follicles and crypts are opened. There may be minute traumatisms (Zwahlenburg, p. 443).

If the obstructed lumen of the appendix is now forced open, the inflammation recedes. Should the obstruction be continued, the inflammation

becomes more and more violent and distention, gangrene and perforation of the appendix results. If the lumen contains no concretions and is not constricted, then when the appendix is suddenly distended by gas forced into its lumen from the cæcum the appendiceal valve is stretched and the appendix is suddenly straightened out and rupture of the mucosa is produced, as a rule, either at the base or near to the tip. On examination of such an appendix it is frequently found that the mucosa lies more or less free in the lumen, the pus has apparently dissected it free from the muscularis. If the process is very advanced the mucosa may be entirely destroyed and the appendix becomes totally gangrenous.

However, if the progress has advanced gradually, the inflammatory area surrounding the appendix may be walled off and a localized abscess results. If, however, the course of the disease is rapid and no peri-appendicular adhesions have taken place, there is a sudden and stormy appendicitis.

Traumatic appendicitis may also be the result of injury to the appendix mucosa by foreign bodies, such as pins, seeds, grapes or enteroliths. Injury to the mucosa of itself is not dangerous as long as there is no obstruction of the lumen, which of itself is a potent cause of appendicitis, and it is the most important cause of the disease. Obstruction by kinks, twists, block the circulation and may produce gangrene.

If a sudden contraction, either of the musculature of the cæcum, or of the abdominal wall such as a protective contraction against a blow, or if the abdomen is squeezed, intestinal contents may be pressed into the appendix and the lumen will be dilated. If an enterolith or foreign body is present in the appendiceal lumen, it may be forced into the narrow communicating opening between the appendix and the cæcum and thus close the opening with somewhat the same action as a ball valve and so obstruction results.

Traumatic appendicitis is more apt to occur in those patients who have a thin abdominal wall in which there is either a lack of fatty tissues or a deficiency of muscular tone (weakness of the muscles or defective development). If, as Warbasse says, a blow on the abdomen can cause injury to the bowel, why can it not cause an injury to the appendix?

Traumatic appendicitis may be of special significance in a medico-legal way. If such a pathological entity is generally accepted, there will be a great increase in the number of suits following upon and induced by an accident. If appendicitis is claimed to be the result of an accident, there should be good corroborative evidence that there has been a more or less continuous train of symptoms from the date of the accident to the time of the acute appendiceal attack. These symptoms should be associated and accompanied by intra-abdominal pain from the time of the trauma to that of the onset of the acute appendiceal attack. This pain is not necessarily in the area of the abdomen where the trauma was received.

If an appendix which is kinked by adhesions is suddenly straightened there is probably some reflex change which normally is interpreted as pain,

but which is shunted out of consciousness by the more immediate and greater local pain caused by the trauma

In traumatic appendicitis vomiting is very frequent. It may occur shortly after the trauma and is a sign of intra-abdominal shock. If it persists, it is an indication of acute peritoneal irritation, such as may result from the rupture of a viscus. However, I have never seen a case in which the vomiting came on and persisted without an intermission between the primary vomiting due to reflex intra-abdominal trauma and the secondary vomiting due to peritoneal inflammatory change. The pulse may go up rapidly for a short time, then it returns to, or almost to, normal, and may remain low until the inflammation has progressed to the point where the appendix ruptures. During all this time there is vague uneasy feeling in the abdomen and on sudden or severe exertion the patient may have pain. During this time also the patient complains of pain on palpation and the pain is localized to the appendiceal area. There may also be mapped out in some cases a dulness over the side of the appendix and the rectus is rigid over this area. After peritonitis has begun there is, of course, a marked rigidity and great tenderness. Tympany may not be excessive, though later when paralysis of the bowel occurs, it is most marked. The symptoms are now those of acute appendicitis.

If the appendix ruptures there is a sudden change. The pulse becomes very rapid and the temperature which has been normal or slightly above normal becomes very high and the patient presents a very sick appearance, for he has a peritonitis which is rapidly becoming generalized. Another symptom group immediately intrudes, namely, the symptom group of ileus. Vomiting becomes persistent and the patient rapidly passes into a state of extreme toxæmia.

Treatment—Appendicitis, wherever and whenever it occurs, if the surroundings are suitable, should always be operated, using the regulation technic. If rupture and peritonitis is present, drainage with a provision for enterostomy should be made. Care must be taken that interference of too severe a character is not undertaken.

In one of my cases, there is no doubt of the relationship between trauma and the resulting appendicitis with resulting peritonitis. In a second case the sequence is not as definite.

The history of the first patient is as follows:

H. R., American, shipping clerk, twenty-eight years old, on entering the hospital complained of pain in the abdomen diffuse in character, nausea, weakness and general malaise. The onset was sudden. On September 9, 1917, Sunday morning after breakfast, the patient was seized suddenly with severe cramps in the lower abdomen. The pain gradually increased in severity. He says he did not vomit but felt weak. That same evening the patient went out to look for a doctor, found one, who gave him electric treatments. That night the patient was very restless, unable to sleep, fussed the whole night. Monday morning, September 10, 1917, the family physician was called. Medications were given. No relief all day Monday, the patient felt miserable. Tuesday morning the patient became worse. The same physician was called in in the afternoon in consultation with another doctor and the parents were advised to rush their son to the hospital. Tuesday night patient entered the hospital.

The patient dates his illness to three weeks ago, when he fell over a tomato patch, landing on a sewer crock, inflicting a bruise on the left side of the abdomen. From this time he had severe pains in the abdomen which were more or less constant. After the first severe onset the tendency was for the pain to be localized in the right side. During this entire time the right lower iliac fossa was very tender to the touch.

The past, personal and family history is negative.

Examination by Doctor Behan on evening of entrance to the hospital—Patient is apathetic. Tongue slightly coated and moist. Chest, right side, dullness lower lobe, vocal resonance increased, breath sound diminished. Left side negative. Heart negative, abdomen distended, very sensitive to touch. Respiration movement of the abdomen is absent. On palpation resistance is increased probably more on the right than on the left side. The patient is tender over the entire abdomen. The slightest touch causes severe pain, deep pressure is not so painful. The patient localizes his greatest tenderness to the abdomen below the umbilicus. When told to localize it with one hand he indicated the right iliac fossa. Dullness is present in the right iliac fossa. Peristalsis is not marked, but is present on both sides. The small waves are most numerous on the left side—the large waves also. On the right side the small waves are entirely absent. Hyperalgesic areas are not well defined. Pulse, 120. Blood examination showed white blood-cells, 17,400, polymorphonuclears, 84 per cent, lymphocytes, 16 per cent. Blood pressure, 88 over 58.

Diagnosis—Generalized suppurating peritonitis primary from the appendix.

Operation—10 45 P.M., September 11, 1917—Spinal anaesthesia—tropocaine one amp and local anaesthesia novocaine one-half per cent, 75 cc. Right rectus incision. The peritoneum was thickened. On opening the peritoneum a considerable quantity of dark, foul liquid exuded. The drainage apparatus was connected and about 400 cc of the fluid was collected in the aspirating flask. The intestines were dark in color and considerably distended. The caecum was bound down to the lateral peritoneal wall and around it were fibrin deposits. An attempt was made to separate the adhesions, but because of their resistance was not persisted. A tube was inserted down into the pelvis. A cigarette drain through a counter opening in the lowest part of the right lower iliac region. Gauze drains were inserted through the operative incision down to the appendix area. The wound was closed. On the left side in the iliac area another opening was made under local anaesthesia into the abdomen. The muscles being split, the same character of fluid was found on opening the abdomen. A cigarette drain was inserted in the direction of the pelvis. About one ounce of foul liquid was obtained by suction. Wound was partially closed. Operating time—about one hour and twenty-five minutes from beginning of injection to the end of operation. Patient left the table in fair condition. Pulse 135. He had hypodermoclysis submammary of 500 cc of sodium bicarbonate 2 per cent and glucose 5 per cent.

September 13, 1917—Blood-pressure was 108 over 65. Patient was dressed. The dressings were saturated. Patient complains when pulling is made on the drains. Abdomen is not distended. Tongue is dry. The patient talks rationally. General condition much improved during the past twenty-four hours. Last night a great deal of distention. At 1 30 A.M. the stomach tube was used. Gas of a foul odor was evacuated. Later the abdomen was distended. The rectal tube was ordered and the condition was relieved.

September 17, 1917—Patient has been restless all night, slept about three and one half hours off and on. Complains a great deal and wants his bed changed to a Fowler's position. Tongue is still dry. Lips very dry and scaly and fissured. Incision clean. Two iodoform gauze drains. One gauze drain reinserted for drainage. Otherwise clean and very little discharge. Abdomen still somewhat distended.

September 18, 1917—Patient has been dressed this morning. Very little discharge present. Drains inserted. Opening drawn together with adhesive plaster. Abdomen greatly distended. Enema ordered, eyes brighter, color better. General condition improved.

TRAUMATIC APPENDICITIS

October 3, 1917—Wound looked good Right side almost healed Left side entirely healed Abdomen flat Patient discharged

One year later Patient still in good health, although he complains at times of pulling and dragging in the abdomen

Reports of Cases from Literature—Borchardt-Moritz (Die Behandlung der Appendicitis mit aus dem Grenzgebieten der Medizin und Chirurgie, Bd xi, p 305) found three cases of traumatism in 150 cases of appendicitis

SCHOTTMULLER reports two cases of children receiving severe blows on the abdomen with immediate signs of peritoneal injury, which later proved to be due to appendicitis

Schottmuller explains the course of the appendicular inflammatory process as follows

- 1 Fecal concretion is present in the lumen

- 2 Through pressure at the point where the stone lodges a necrosis and ulceration of the inner wall of the appendix results This is not dangerous and produces no symptoms However, if now there is a sudden trauma, the thin-intact outer wall is torn or will be destroyed The infectious contents are now forced out into the free peritoneal cavity and peritonitis results The sudden rupture and the overwhelming of the peritoneal cavity by the infection explains why in these cases we have no adhesions

BLOCK, in the *Denver Medical Times*, states that out of 129 cases of appendicitis, traumatism was quite positive in three cases The first case fell, symptoms with severe abdominal pain, developed six hours after falling from a bicycle The second case was kicked by a pony, over and just to right of umbilicus Pain severe in abdomen, most marked over gastric region Third case, lifting heavy furniture, four hours later severe pain in right side of abdomen

SMALL reasons that trauma is instrumental in causing the increase in appendicitis over former years He says that 75 per cent to 80 per cent in young adults, of appendicitis, is caused from trauma Seventy-five per cent are under thirty years of age He cites the case of a boy nine years old who had pain come on while he was pushing a heavy cart, the tongue of the cart was pressing against his abdomen On operation, five days later, pus was found in the abdomen The appendix had sloughed away

SOUTHAM, in the *Lancet*, reports four cases of traumatic appendicitis He believes that severe strain may cause sudden and forcible contraction of the abdominal muscles and so separate or break down adhesions between the appendix and the abdominal wall and cause an extravasation of blood, either into or around the appendix

In one case, in a boy nine years of age, there was no history of any previous pain He had been struck on the abdomen There was pain in the right iliac area The next day he was confined to bed He vomited constantly, on the fourth day temperature was 100, pulse 120 Operation, appendix inflamed, almost perforated in one spot Contained a concretion Numerous recent adhesions around the appendix Pus was diffused throughout the peritoneal cavity

In cases of traumatic appendicitis it is usually claimed that the pain generally comes on immediately after the trauma and is frequently though not absolutely localized to the right side In three out of the four cases of Southam it was not at first localized, but gradually became so

LADUSKI reports one case of a boy, eleven and one-half years, who had some slight cramps in the abdomen prior to a fall on the abdomen while sliding down a banister. Immediately after the fall he had pain in abdomen, nausea and vomiting On operation the abdomen was found filled with blood and a rent of about one and one-half inches was present at the end of the meso-appendix In this there were several small bleeding vessels The patient recovered

WARBASSI, *New York Medical Journal*, vol iii, No 8, pp 411-413 believes that as a rule there is some pain present in the abdomen at the time of the traumatism This

may entirely disappear and no unusual symptoms be present for one or two days, then the pain recurs in the right side and a well-defined appendicitis becomes evident

DEAVER says that in a previously healthy appendix, he has never seen appendicitis produced by a blow or traumatism

WARBASSE further states that traumatism may be due to the following

- 1 Abrasion of mucosa by foreign matter
 - 2 Lowering of the vitality of the mucous membrane cells by retained secretions
 - 3 Distention of follicles by retained bacteriological products
 - 4 Presence of an excess of ptomaines retained in the appendix against the pressure of the contents of a distended cæcum
- If traumatism can cause injury to the bowel, why not, as Warbasse says, cannot it cause injury to the appendix?

SAVAGE, in *Medical Record*, reports a case, sixty-one days old, where the appendix and colon were down in a scrotal right inguinal hernia. For one week efforts at reduction by taxis were made. Operated caput-coli in sac, appendix inflamed and perforated. Death in two days.

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REPORT OF ADDITIONAL CASES

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OWING to the number of different names under which the lesion has been described as "membranous," "pseudomembranous," "croupous," "diphtheritic," "exfoliation," "plastic," and "gangrenous cystitis," which are misleading, it is impossible to state the exact number that have shown necrosis with putrefactive changes. Wolferth and Miller found 9 gangrenous and 12 of necrosis in the 21 cases which they reported.

Willis,¹ in 1650, was the first to describe necrosis of the urinary bladder, Tulpius,² in 1716, and Fontaine,³ in 1815, without microscopical examination of the bladder. Bauer,⁴ in 1853, reported a case which was studied microscopically by Lusk.⁵

The first cases to be reported with accurate histological examinations were by Levee,⁶ 1853, and Lee,⁷ 1863. Dolbeau,⁸ in 1864, reported a case which occurred with calculi in the bladder. May,⁹ in 1869, and Heubner,¹⁰ in 1883, produced necrosis of the bladder experimentally on rabbits and dogs.

Guyon¹¹ described fully two types. First, the false and pseudomembranous type, which may be called diphtheritic, where the membrane is a fibropurulent exudate, and, second, necrosis of the bladder.

Haultain,¹² in 1890, reported 2 cases and collected 54 cases from the literature.

In 1910, O'Neill¹³ reported 2 cases and collected 50 additional cases from the literature not included in Haultain's report, making 108 reported cases of necrosis or gangrene of the bladder.

Wolferth and Miller,¹⁴ in 1924, reviewed the literature and added 19 cases of their own, making a total of 153 cases of necrosis and gangrene of the urinary bladder.

Pausson¹⁵ in 1894, reported 17 cases of extroversion of bladder through the urethra which he observed to the end, 6 deaths were due to gangrene of the bladder, and urinary infection (not included in reports 13, 14 and 19).

Since my first communication on this subject¹⁶ Elhason²⁰ has reported a case of spontaneous rupture of gangrenous urinary bladder occurring in a woman, age thirty, diagnosed as appendicitis. The gangrenous area was excised and the patient recovered.

Costantini, Bernasconi and Dulouchet²¹ reported 2 cases. (1) A male, age fifty-five years, died with gangrene of the bladder following an operation for prostatic abscess. (2) Female, age forty-two years, with a history of three pregnancies, lues and retention of urine four years previous to entering

* Read before the Wisconsin Urological Society, Madison, October 29, 1926

hospital with hæmaturia, retention of urine and urethral discharge. Cystoscopic examination showed 1200 c.c. residual urine with gangrene of the bladder. Treated by Dakin solution, irrigations, recovered.

To the above 167 cases, I wish to add 6 cases which occurred on the autopsy service at the University of Maryland since July, 1924, making a total of 173 cases of gangrene of the urinary bladder.

CASE 168—Colored, female, age thirty-five years, admitted to the University Hospital, March 14, 1925, from the outside obstetrical service after having been in labor twenty

four hours with a clinical diagnosis of abruptio placentæ, a still-born child was delivered by version and breach extraction. The general condition of the patient was fairly good for the next few hours, but after this her condition grew steadily worse until she died March 17, 1925, with a clinical diagnosis of abruptio placentæ, undetermined hemorrhagic condition in stomach, bladder and lower intestines.

Autopsy No 1119—Bladder—Muscular wall is thickened (6 to 8 mm.) with the mucosa of the trigon and base of a greenish-black color. A putrid odor is present. On the fundus a yellowish exudate is found in areas. Ureteral orifices are scarcely visible.

Anatomical Diagnosis—Gangrenous endometritis with perforation of the lower anterior wall of the uterus into the peritoneal cavity, hemorrhagic, acute gangrenous

FIG 1—Case 171. Autopsy No 1158. Gangrenous cystitis following suprapubic prostatectomy, ureteral dilatation, bilateral (adenocarcinoma of prostate)

rhage into peritoneal cavity, acute generalized peritonitis, cystitis, acute phlegmonous gastritis, acute enterocolitis, acute diffuse nephritis, hydro-ureter, bilateral¹⁰, hydronephrosis, bilateral, pyelitis, bilateral.

CASE 169—Colored, female, age twenty-five years, admitted to University Hospital, July 20, 1925, with a clinical diagnosis of chronic salpingitis with tubo-ovarian abscess. Her condition gradually improved until August 14, 1925, at which time a supravaginal hysterectomy and bilateral salpingo-oophorectomy were performed by Dr. J. M. Hundley, Jr. An adherent mass was found to consist of adherent intestine, great omentum, tubes and ovaries, adhesions were freed with great difficulty and some bleeding. The mass was also adherent to the fundus of the bladder, and on relieving these adhesions, two small perforations were made in the fundus of the bladder, which were closed by No. 1 plain catgut.

Autopsy No 1147—August 21, 1925. *Bladder*—On the fundus there is an opening measuring 1 cm. in diameter, with catgut sutures adherent to its edges. In the left

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posterior margin of the fundus a second opening 1 cm in diameter is seen, with catgut sutures adhering to its edges. The muscular wall varies from 5 to 9 mm in thickness. Mucosa is covered by a yellowish exudate in several areas. Upon removing the exudate, the mucosa is of a reddish-green color, just above the trigon and surrounding the perforations it is of a greenish-black color. Urethra shows the mucosa to be of a bright reddish color, with some exudate adherent to it.

Anatomical Diagnosis—Acute gangrenous peritonitis, pelvic portion, acute generalized peritonitis, upper half, subhepatic abscess, subdiaphragmatic abscess, gangrene of the bladder, cæcum, and sigmoid, with perforation in bladder and sigmoid, acute diffuse nephritis, bilateral, pyelitis, bilateral, ureteritis, bilateral.

CASE 170—Colored, male, age sixty-three years, admitted to University Hospital, September 29, 1925, service of Dr W H Taulson, for acute retention, uræmia, multiple calcified strictures of the urethra, chronic purulent cystitis, inguinal hernia, left, terminal broncho-pneumonia. Under local anæsthesia a suprapubic cystotomy was performed. Patient died September 30, 1925.

Autopsy No 1151—Prostatic urethra is moderately dilated. The veru is of a dark red color, with a purulent exudate exuding from the ejaculatory ducts. Membranous urethra is markedly dilated, with a large calculus in this dilated membranous urethra 3.5 by 2.5 cm. At the proximal portion of the penile urethra a band of scar tissue is seen surrounding the

urethra. Anterior to this stricture the urethra shows small areas of a dark red color, and an exudate can be pressed out of the glands of Littre.

Bladder—The muscular wall is markedly thickened, measuring from 8 to 12 mm in thickness, with a rubber catheter in the fundus of the bladder. Mucosa is of a dark greenish-black color throughout with a putrid odor present. The trigon is reddish-green in color. Urethral orifices gaping.

Anatomical Diagnosis—Stricture of urethra junction of anterior and membranous, dilatation of membranous urethra, large calculus in membranous urethra, chronic prostatitis, gangrenous cystitis, localized, ureteritis, bilateral, pyelitis, bilateral, hypertrophy of the bladder, chronic epididymitis, left, with abscess formation. Chronic diffuse nephritis with acute diffuse nephritis.



FIG 2—Case 173. Autopsy No 1190. Gangrenous cystitis extending down into prostatic cavity following suprapubic prostatectomy. (Adenoma of prostate.)

CASE 171—White, male, age sixty-two years, admitted to the University Hospital, July 21, 1925, service of Dr W H Toulson, with a diagnosis of carcinoma of the prostate August 26, 1925, a suprapubic cystotomy was performed under local anesthesia November 5, 1925, suprapubic prostatectomy Patient died in uræmic coma, November 7, 1925

Autopsy No 1158—Bladder—There is an opening in the fundus 1 cm in diameter with a rubber tube extending into the bladder On the lateral wall there is an area 3 by 4 cm which is of a dark blackish-green color with a putrid odor present Trigon is of a dark red color with the ureteral orifices visible Vesical orifice shows numerous tags In the prostatic urethra a portion of the prostate is adherent to the prostatic capsule

Anatomical Diagnosis—Adenocarcinoma of the prostate with metastasis to the lymph-nodes along the internal iliac arteries, abdominal aorta, renal arteries, and liver, hydro-ureter, bilateral, hydronephrosis, right, gangrenous cystitis, chronic diffuse nephritis, acute diffuse nephritis

CASE 172—Colored, male, age fifty-five years Admitted to the University Hospital, November 18, 1925 Service of Dr W H Toulson

Clinical Diagnosis—Acute retention of urine, hypertrophy of the prostate

Operative Note—November 18, 1925, suprapubic cystotomy under local anesthesia December 7, 1925, suprapubic prostatectomy The peritoneum was accidentally opened Prostate—each lobe measured 5 cm in diameter when removed Microscopical diagnosis—adenoma of prostate

Autopsy No 1165—December 20, 1925 Bladder—There is a recent operation wound in the fundus The muscular wall is markedly thickened, varying from 2 to 3 cm in thickness The peritoneal surface is smooth and glistening The muscular wall shows the line markings to be indistinct in outline in the fundus The base and lower 3 cm of lateral wall is of a greenish-black color, with a putrid odor present, in this region no line markings are visible Mucosa—the base and lateral walls are of a greenish black color with yellowish necrotic material on its surface in areas Ureteral orifices scarcely visible, at the fundus the mucosa is of a dark red color Just above the left ureteral orifice a diverticulum 2 cm in diameter is seen

Anatomical Diagnosis—Recent operation wound—suprapubic, abscess of prostatic gland, acute gangrenous cystitis, ureteritis, bilateral, pyelonephritis with abscess formation, bilateral, hydro-ureter, right, adhesions between coil of ileum and operation wound, adenoma of adrenal, right²²

CASE 173—Colored, male, age fifty-nine years, admitted to the University Hospital, February 9, 1926, service of Dr W H Toulson Clinical diagnosis hypertrophy of the prostate, infection of upper urinary tract February 14, 1926, suprapubic cystotomy March 15, 1926, suprapubic prostatectomy Patient died March 31, 1926, from uræmia

Autopsy No 1190—Bladder—Muscular wall is markedly thickened (2 cm) In areas it is soft The mucosa is scarcely visible, most of the bladder being covered with a thick layer of greenish-black necrotic material with yellowish necrotic material in areas This greenish-black material extends down into the prostatic urethra, the prostate being absent

Anatomical Diagnosis—Recent operation wound suprapubic, absence of prostate gland, gangrenous cystitis, hydro-ureters, bilateral, hydronephrosis, bilateral, pyelonephrosis, bilateral, acute diffuse nephritis, etc

Etiology—Necrosis or gangrene of the bladder occurs as a result of
1 Interference with the circulation, internal or external pressure 2 Infection, general or local, with or without mechanical injury 3 Lesions of the central nervous system 4 Chemical irritants

Incidence—Gangrene of the urinary bladder occurs more frequently in females—116 females, 57 males (including the six cases of this report) The

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age varies from three years to seventy-five years, with the majority of cases occurring in the third and fourth decades

Mortality—In the 173 cases 102 died, 67 recovered, and the outcome is not stated in 4

Discussion—In reviewing the 173 cases of gangrene of the urinary bladder, it is seen that 40 cases were associated with retropregnant uteri, 23 occurred after labor—15 of which had retention of urine, 11 were due to external pressure in females with retention in 6 of the 11 cases, cystitis was the antecedent in 14—7 males, 7 females, 7 of the 14 cases of cystitis were complicated by retention, stricture of the male urethra 9 cases, with calculi in the urethra in 3 of the 9 cases, retention 8, prostatic obstruction 6 with retention in each case, calculi in bladder 6, retention 6, irritants 6—2 males, 4 females, retention 1, general infections 15—4 males, 11 females, retention 7, lesions of the central nervous system 12, males 8, females 4, retention 7, trauma 5, males 3, females 2, retention 3, extroversion of bladder through the urethra 6, females, miscellaneous 20, males 11, females 7, retention 10

Retention of urine was present in 76 of the 173 cases (48.5 per cent)

Obstruction to the circulation will explain the cases of simple necrosis, but to have putrefaction changes it is necessary to have a pathogenic bacteria present, and from the variety of conditions that have been associated with gangrene of the bladder it is quite evident that infection, primary or secondary, was present

In the sixty-seven cases that recovered the diagnosis was made by cystoscopic examination, suprapubic cystotomy or examination of the exudate passed per urethram

CONCLUSIONS

1 One hundred and sixty-seven cases of necrosis and gangrene of the urinary bladder are collected from the literature

2 Six cases of gangrene of the bladder are reported

The writer is indebted to Prof. Hugh R. Spencer for the many privileges which he received during his seven years as a member of the pathology staff at the University of Maryland

BIBLIOGRAPHY

- ¹ Willis Dissertatio de Urinis, 1650
- ² Tulpus Observ. Med. Lugdani Batavorum, 1716
- ³ Fountaine Catarrhe de la Vessie, Thesis Paris, 1815
- ⁴ Bauer Med. Corresp. Bl. d. Würtemb. ärztl. Ver. Stuttgart, 1853, vol. XXIII
- ⁵ Lusk Virchow's Arch., 1854, vol. XXX
- ⁶ Lever Guy's Hospital Reports 1853 vol. VIII, p. 49
- ⁷ Lee Path. Trans. London, 1863, vol. XX, p. 136
- ⁸ Dolbeau Tr. Proc. de la Pierre dans la Vessie 1864 p. 309
- ⁹ May Inaugural Dissertation Gießen 1869
- ¹⁰ Heubner Die Experimentelle Diphtherie Leipzig, 1883
- ¹¹ Guyon Annal. des Mal. des Org. Génito-Urinaires July and August, 1887
- ¹² Haultain F. W. N. Laboratory Reports of Royal College of Physicians, Edinburgh 1890 vol. II p. 216
- ¹³ O'Neill R. F. Surg. Gynec. and Obstet. 1910 vol. X p. 503

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- ¹⁴ Miller, T G , and Wolferth, C C Jour Amer Med Assoc , 1922, vol lxxix, p 1756
- ¹⁵ Miller, T G , and Wolferth, C C Amer Jour Med Sci , 1924, vol clxvii, p 339.
- ¹⁶ Judd, E S, and Meeker, W R. Jour Urol , 1924, vol xi, p 411
- ¹⁷ Aschner, P W Jour Urol , 1924, vol xi, p 252
- ¹⁸ Pausson, A Inversion de la Vessie et sa Hernie, Annales des Malades org genit urin , 1894, vol xii, p 408
- ¹⁹ Carson, W J Jour Urol , 1925, vol xiii, p 205
- ²⁰ Elhason, E L ANNALS OF SURGERY, 1925, vol lxxxi, p 546
- ²¹ Costantini, Bernasconi and Duloucher Revue De chirurgie, Paris, 1924, vol cxii p 590
- ²² Spencer, H R. Adenoma of the Adrenal, Archives of Pathology and Laboratory Medicine, 1926, vol ii, p 691

LIPOMA OF THE TESTICLE

WITH A CONSIDERATION OF FAT ATTACHED TO THE INGUINAL
AND SCROTAL PERITONEUM

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OF OMAHA, NEB.

GALEN described fatty masses within the scrotum as attached to the spermatic cord and testicle, calling them *steatoceles*. Ambroise Paré also described scrotal lipomata, feeling that they preceded inguinal hernia through the internal inguinal ring and that they were the etiologial factor in the descent of the bowel. The works of de Garengeot, Morgagni, Paré, Scarpa, Monod and Terrillon, Gage and Fish and the new book on hernia by Watson treat this subject of scrotal and inguinal fat most interestingly. Throughout the literature, fatty masses within the inguinal canal and scrotum have been termed fatty hernias and fatty tumors of the testicle respectively. Fatty inguinal hernias are, in reality, hyperplastic masses of subperitoneal fat attached to the vaginal process of the cord. In the few reports I could find of tumors of the testicle, it was not difficult to decide that in most instances they were examples of hyperplasia of the fat surrounding the lower portion of the spermatic cord, which had projected downward into the scrotum. The case I am reporting can stand as a lipoma originating from the testicle, providing the mesothelial coat of the testicle, the tunica vaginalis viscerum is considered a part of this organ. The true capsule of the testicle, tunica albuginea, perhaps originating from the transversalis fascia, is also an acquired structure, and in order to satisfy the most critical, a true lipoma of the testicle should arise from within the tunica albuginea. Fat within this tunic has been found normally only in the mediastinum testis. Since the lipoma I am reporting arose from the visceral layer of the tunica vaginalis, perhaps I should, to be more exact, report this as an example of "Hyperplasia of the Subperitoneal Fat beneath the Mesothelial Coat (tunica vaginalis viscerum) of the Testicle."

EMBRYOLOGY

Fat within the inguinal canal is frequently seen during herniotomies, and when occurring as a mass, is generally called a fatty hernia. Fat within the inguinal canal and scrotum should not be looked upon as abnormal and a study of the embryology of the scrotum and inguinal canal, together with their contents, signifies that fat is a normal content.

The scrotum is formed by a constriction of the lower walls of the abdomen. This constricted portion of the lower abdominal wall naturally contains peritoneum which lines the scrotum from the time of its origin, and later when the testicle descends, wraps itself around this organ forming both of its tunics, i.e., vaginalis viscerum and vaginalis parietum. Therefore, the

mesothelial tunics of the testicle and cord, which are nothing more than constricted peritoneum, precede the testicle and cord into the scrotum. In exploring undescended testes the so-called sac is always found extending lower than the testicle, proving its priority *in situ*.

One characteristic of subperitoneal areolar tissue is the favoring of depositions of fat, which is so beautifully shown by the work of Gage and Fish (*American Journal Anat*, 1924). If the intra-abdominal subperitoneal

tissue favors fat deposition it is natural to assume that the inguinal and scrotal subperitoneal tissue would also. We see this demonstrated in operating upon inguinal hernias where so frequently we find fat deposited along the cord and connected, through the internal inguinal ring, with the intra-abdominal subperitoneal fat. Therefore, so-called fatty tumors of the testicle, unless proven to arise from the mediastinum testis, perhaps had better be looked upon as hyperplasia of the subperitoneal fat originating from the areolar tissue beneath the tunica vaginalis viscerum, or "the testicular peritoneum".

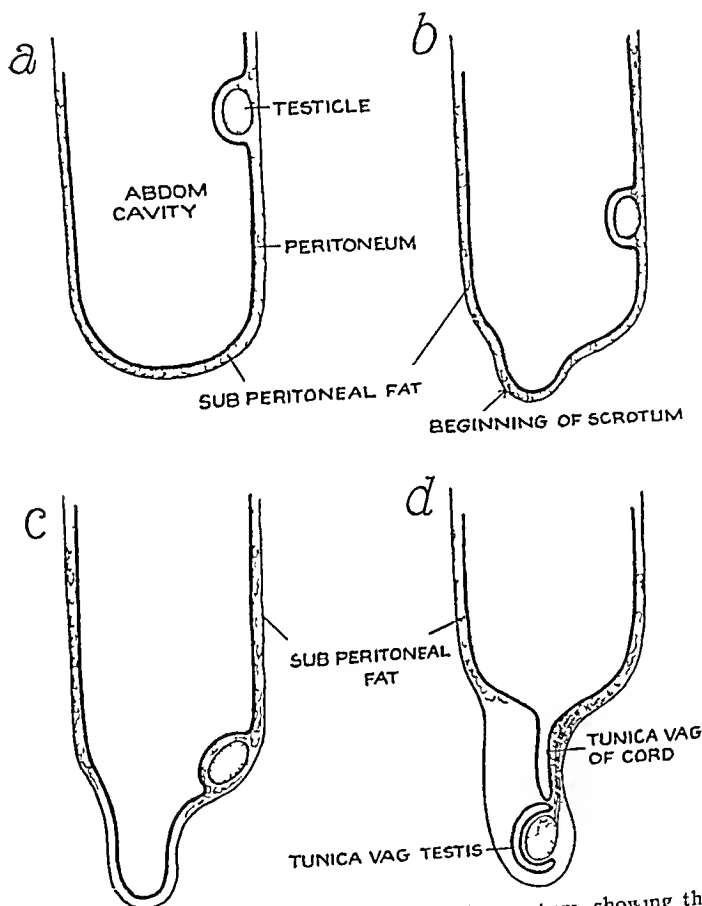


FIG. 1.—Embryological formation of the scrotum showing the natural tendency of deposition of subperitoneal fat around the testicle and spermatic cord.

Historical—After a thorough search of the literature in preparation of an article read before the Minnesota State Medical Association in June, 1926 entitled "The Relation of Subperitoneal Fat to Abdominal Hernia," and which took in all reports I could find of fatty growths in the scrotum from the time of Hippocrates, I could find only eight reports of Lipomas of the Testicle, which bore scrutiny. A few other articles, of similar title, when carefully analyzed were easily determined to be tumors originating from the lower portion of the spermatic cord. Monod and Terrillon (*Traité Des Maladies du Testicule et de Ses Annexes*, Paris, 1889, p. 699) in the most complete work up to 1889 on diseases of the testicle and annexed structures state that the only true case they were able to find was that reported by Roswell Park. After reporting his case, Park cites the cases of De Guise and Jobert as tumors of the testicle. I found, however, that both De Guise

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and Jobert first thought that they each had found a lipoma of the testicle, but upon careful dissection they found in each instance that the tumors had descended from the lower portion of the spermatic cord. Even Park's famous case can be looked upon as more likely originating from the lower spermatic cord than from the testicle. Theodor Kocher reports two cases as lipomata of the testicle, but upon careful study of his articles, I feel that both were undoubtedly lipomata originating from the lower portion of the spermatic cord. J. A. Oll and J. Morgan each report fatty tumors of the testicle, they described them as discharging fungoid masses. In my estimation then reports are indefinite. The case of H. J. De Roo, I think, is a true fatty tumor of the testicle as well as the case reported by H. A. W. A. H. Grote. It is interesting to note that Karcwski reports a case of lipo-sarcoma originating from the tunica vaginalis testes.

CASE REPORTS

I—AUTHOR'S CASE—

Patient fleshy type, age forty-two, past history negative. A left inguinal hernia had been present for twenty years and a hydrocele of the tunica vaginalis testis about 8 cm. in diameter for eight years. Both hernia and hydrocele were gradually increasing in size and causing more distress. At operation, I found an indirect inguinal hernia with an acquired sac extending down to the testicle. Surrounding the cord and beneath the sac was a continuous and complete layer of fat extending from the testicle up to and through the internal inguinal ring. After the sac of the hydrocele had been cut away as much as possible, a small nodule beneath the testicular layer of the

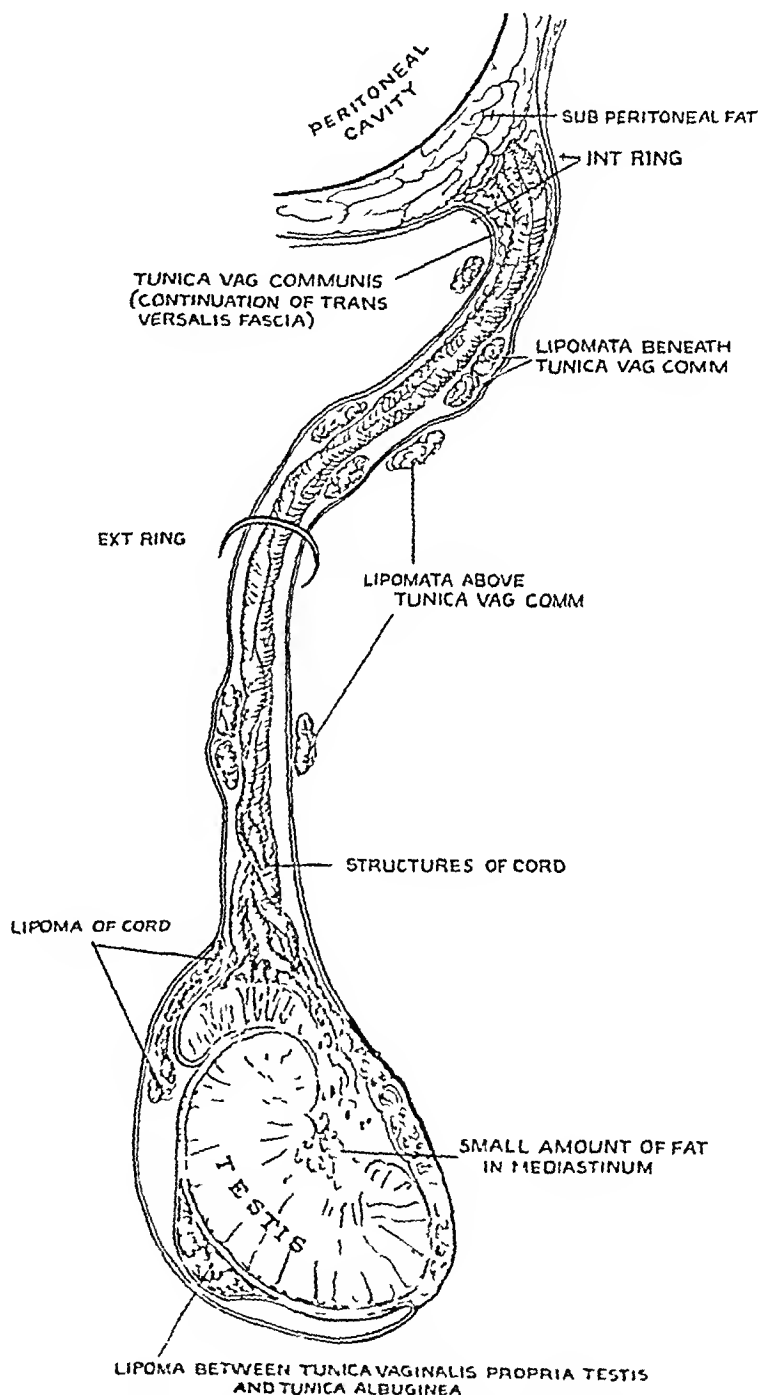


FIG. 2—Fatty tumor of the testicle which may have arisen from subperitoneal fat deposited beneath the tunica vaginalis viscerum.

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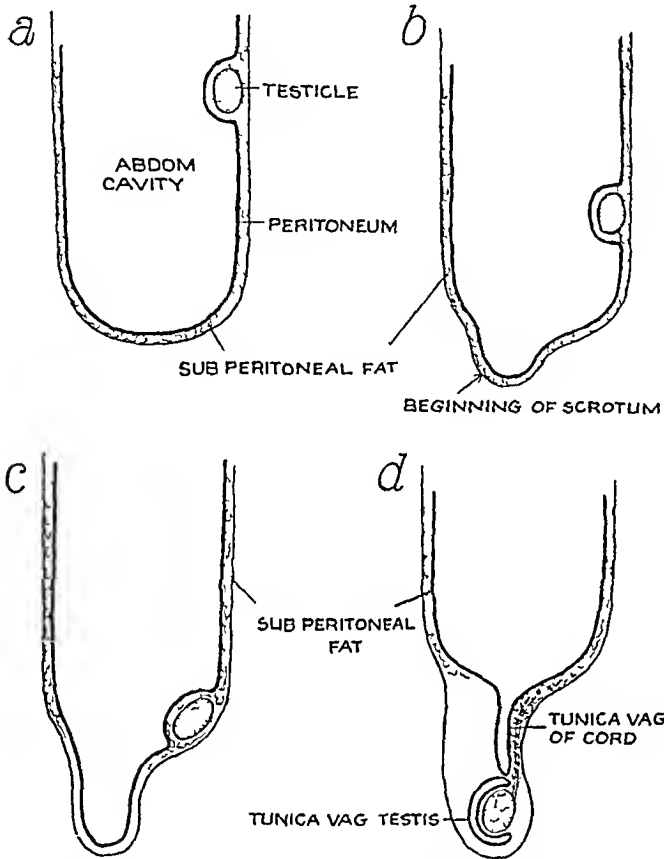


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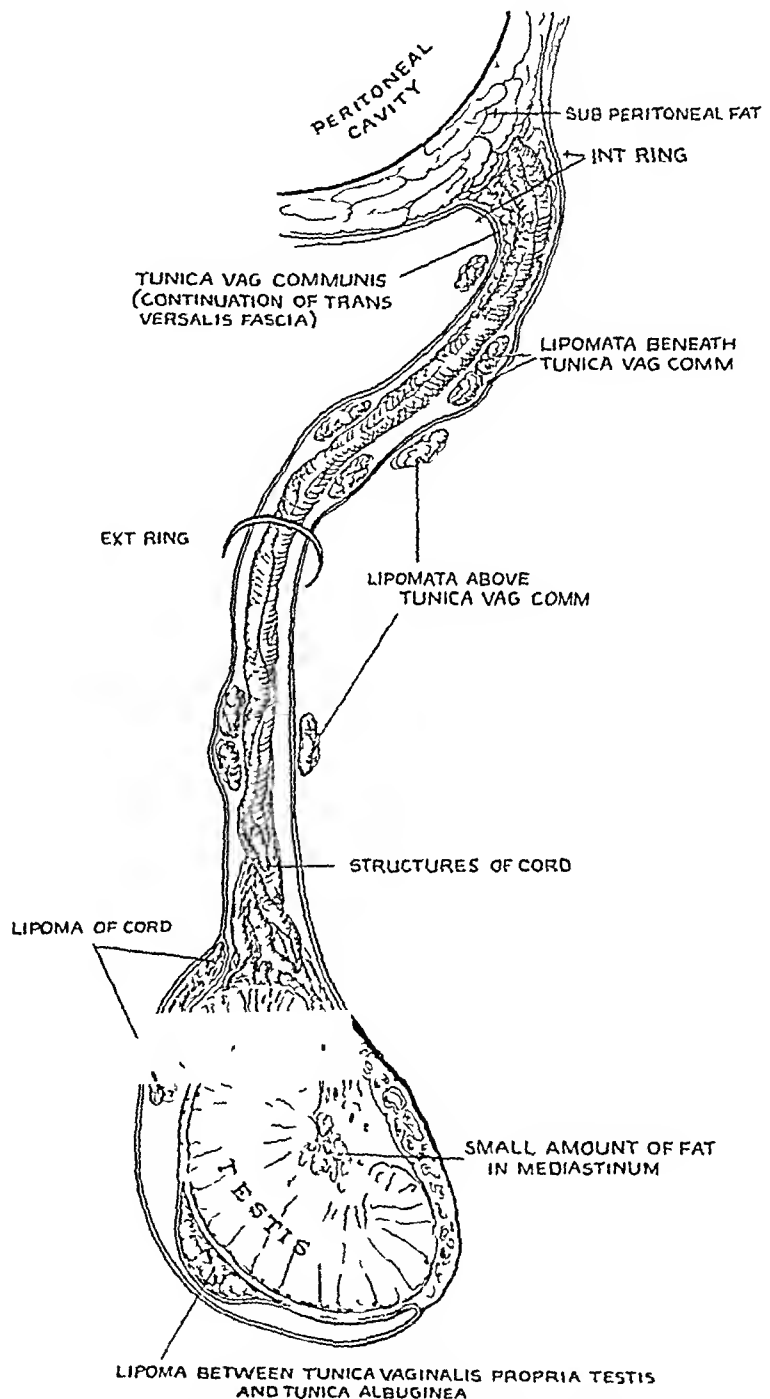


FIG. 2.—Fatty tumor of the testicle which may have arisen from subperitoneal fat deposited beneath the tunica vaginalis viscerum.

tunica vaginalis was noted. An incision showed it to be a fatty nodule well encapsulated and more intimately attached to the tunica vaginalis than to the tunica albuginea. It was so easily determined to be fat that a microscopic section was not made (Fig 2)

II—DE ROOY, H. J.—*Insigni tunica vaginalis testis degeneratione, aliorumque organorum vitis, in cadavere senis 104 annorum observatis*. Thesis, Lugduno-Batava, 1823

"During an autopsy on a man 104 years old, a tumor was found in his right scrotum, which was about the size of the head of a new-born infant. The viscera, excepting a slight lobulation of the liver, were in their normal condition. The prostate was enlarged and dense in structure and the seminal vesicles were collapsed. The most conspicuous feature was "the singular degeneration of the tunica vaginalis of the right testicle." The tumor was elastic in some portions and almost bonchard in others, with intervening fluctuating parts, its size was four thumb lengths by three and one-half thumb lengths. The exact location of the testes was not possible. The vasa spermatica, the vas deferens and the epididymis seemed healthy.

The tumor tissue looked crystallized and cold water did not dissolve it. Cold alcohol likewise did not change the crystals, but hot alcohol did. The tumor was made up of adipose substances which by Fourcroy has been called 'Adipocerae (adipocire)'"

III—GROTE, H. A. W. A. H.—Inaug. Thesis, Gottingen, 1908

Patient, age thirty, an epileptic. Eight years previously had noticed a pea-size tumor apparently attached to the left testicle. The past two years the tumor had grown to the size of a hen's egg. During the past six months, another tumor had developed close by. At operation, a fatty tumor, the size of a hen's egg, was found with a few attached nodes of fat the size of a bean. It was attached to the testicle for about a pencil's breadth. The epididymis and the testicle were found to be normal. Grossly the tumor was composed entirely of fat and covered by the tunica vaginalis on the sides and back. Microscopically it contained numerous fibro-myomatous nodules which were very cellular and of the fibro-sarcomatous type.

IV—PARK, ROSWELL. ANNALS OF SURGERY, 1886

Patient, age forty, presented a tumor of the scrotum the size of a foetal head. After removal it weighed three pounds. Park states that he could not determine the exact origin of the tumor, i. e., from the testicle or lower portion of the spermatic cord. He stated that the condition was rare and could find only two other reports of lipomata of the testicle, those of De Guise and Jobert.

V—DE GUISE. Ann Soc de Chir. Paris. Ire serie, T9, 529, Juin, 1859

This case, reported by both Park and De Guise as a fatty tumor of the testicle, was found to be, after a careful dissection by De Guise, a fatty tumor originating from the lower portion of the spermatic cord.

VI—JOBERT, L. Mem Soc Biol. Paris. Ire serie, 2, 78, 1850. Gazette Med de Paris, 1850

This case, also reported by Park, was found, after careful dissection by Jobert, to be a fatty tumor originating from the lower portion of the spermatic cord.

VII—KOCHER, TH. Krank, des Mannlichen Geschlechtsorgane. Deut Chir., 1887, p 183

From Kocher's own description, he admits that he was unable to determine whether or not the tumors came from the lower cord or testicle.

VIII—ORR, J. A. Dublin Medical Press, 1847, vol. xii, p 56

Reports a case of lipoma of the testicle. Speaks of the tumor as a granular or fungus mass. Description indefinite.

IX—MORGAN, J. Dublin Medical Press and Circular, 1867, vol. iv, p 546

Reports a case of fatty tumor of testicle. Describes it as a fungus discharging mass. Case doubtful.

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BIBLIOGRAPHY

- ¹ Callisen Systema Chir Hodiernæ, 2, Ed 1827
- ² Curling Treatise Diseases of Testicle, 1856
- ³ Curling Todd and Bowman's Ency Anat and Phys Disease of Testicle, 4th Ed, 1878
- ⁴ De Carengeot, R J C Mem Acad Roy de Chir, Paris, vol 1, p 669, 1743
- ⁵ De Guise Ann Soc de Chir Paris Ire serie, T9, p 529, Jun, 1859
- ⁶ De Rooy, H J Thesis, Lugduno-Batava, 1823
- ⁷ Gage and Fish Am Jour Anat, Sept, 1924
- ⁸ Galen Quoted by Curling
- ⁹ Gascoyen Tr Path Soc, vol xvii, 1867
- ¹⁰ Grote, H A W A H Inaug Thesis, Gottingen, 1908
- ¹¹ Jobert, L Mem Soc Biol Paris, ire serie, vol 11, p 78, 1850 Gazette Med de Paris, 1850
- ¹² Karewski Klin Chir, 1895, vol xlix
- ¹³ Morgagni De sed et Caus Morb and Epistle 43, a 10, u and Epistle 50, p 24, 1740
- ¹⁴ Morgagni De sed et Caus Morb, 1761 (Translated by Benjamin Alexander)
- ¹⁵ Morgan, J Dublin Med Press and Circular, vol 1v, 1867
- ¹⁶ Monod et Terrillon Traite Des Maladies du Testicule et de ses Annexes, Paris, 1889
- ¹⁷ Orr, J A Dublin Med Press, vol xvii, 1847
- ¹⁸ Pare, Ambroise Ouevres, C, 15, p 196, 1564
- ¹⁹ Park ANNALS OF SURGERY, 1886 Phila Med Times, May 15, 1886
- ²⁰ Scarpa Hernia Linea Alba Sull' Ernie, 1809
- ²¹ Scarpa Traite Pratique des Hermæ, 1812 Translation by Wishart, Edinburgh, 1814
- ²² Watson, F F Hernia, 1924

TORSION OF AN INTRA-ABDOMINAL TESTIS

By JOHN K. ORMOND, M.D.

OF DETROIT, MICH.

FROM THE DIVISION OF UROLOGY OF THE HENRY FORD HOSPITAL

A MAN, aged forty-two years, married, and father of two children, was admitted to the Henry Ford Hospital as an emergency on October 7, 1923, complaining of pain in the right side of the abdomen of two days' duration. The pain had come on suddenly during coitus, had been intermittent in character, and had not been extremely severe. It had not radiated nor had it been accompanied by nausea, vomiting or urinary symptoms. There was no history of previous attacks.

There was nothing of great interest in the past history except that the right testicle had never been in the scrotum. Two years previous he had a left inguinal hernia repaired.

Except for the abdomen and external genitalia, the general physical examination revealed no striking abnormalities. The patient was a well-developed man, in no great pain, there was cloudiness of the left maxillary sinus, and chronic tonsillitis, the heart and lungs seemed normal, and the blood-pressure was 126/84.

There was some tenderness and muscular resistance on the right side of the abdomen, with its maximum at McBurney's point and a little below. No mass was palpable. The right testicle was absent from the scrotum, and could not be felt in the inguinal canal, the left testicle was apparently normal. The inguinal glands were not enlarged, there was no urethral discharge, the prostate was normal in size, shape and consistency, and the expressed fluid showed about 25 per cent pus cells. No hemorrhoids noted.

On admission the temperature was 98.4°, pulse 86. Leucocyte count 8200 with a polymorphonuclear percentage of 72. A few red blood-cells were found on the first urine examination but later examination showed no pus, blood, albumin or sugar. The blood Wassermann test was negative.

X-rays were taken of the urinary tract and no shadow suggestive of ureteral calculus was seen. Cystoscopy was done and failed to show any obstruction in the right ureter, the function of both kidneys was excellent and the pyelogram of the right kidney presented no unusual features.

The patient was observed for several days, his temperature rising to 99.8° on the second day of his admission and never rising above normal after that period, his pulse was never rapid and his leucocyte count never increased. He was never in extreme discomfort and had periods of complete comfort, but as his symptoms did not clear up an exploratory operation through a right rectus incision finally was done. The pre-operative diagnosis lay between subacute appendicitis and some lesion of an intra-abdominal testis.

At operation there was found a mass consisting of a black swollen testicle, with one complete twist of its mesentery, and adherent to this mass was the tip of the appendix which showed signs of very mild chronic appendicitis. The appendix and testicle were removed and recovery from operation was uneventful.

The case here reported is of special interest as only five other cases of torsion of an intra-abdominal testis could be found in the literature. They are of sufficient interest to be given in abstract.

I. GERSTER, in 1897 presented a patient before the New York Surgical Society. He was twenty-one years old with third degree of hypospadias, absence of corpus spongiosum, and undescended testicles. The day previous to admission he had a sudden pain in the right iliac fossa, swelling developed and there was vomiting and fever.

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Examination showed a tender globular mass the size of a child's head in the right iliac fossa. At operation this mass proved to be the right testicle which was the seat of a malignant tumor and had become twisted on its pedicle.

2 STILES, in 1905, reported a case in a man thirty-nine years old. There had been sudden onset of severe abdominal pain with vomiting. He recovered from this in three days. There were four subsequent attacks, in the fourth of which he was seen by Stiles, who made a diagnosis of torsion of the right intra-abdominal testis and operated. At operation the testicle was found to be the seat of a sarcoma and had undergone torsion.

3 LeCONTE, in 1907, reported the case of a young Italian, twenty-eight years old, who had been in good health until ten days before admission to the hospital. Then he had pain in the abdomen, anorexia, nausea and fever. Three days before admission the pain became severe, confining him to bed.

Examination showed general abdominal tenderness, especially in the right iliac fossa, where there was a sense of tumor and where there was marked rigidity. The right testicle was undescended, temperature 100.4° , pulse 96, respiration 22. Appendicitis seemed to have been suspected and operation was done. At operation an ovoid tumor the size of an orange was removed. The pathological diagnosis was sarcoma and torsion of the testicle.

4 HOWARD, in 1907, reported the case of a fifteen-year-old boy on whom he had operated two years before for bilateral undescended testicles. At that time he had replaced the right testicle in the abdomen and had brought the left down into the scrotum. Two years later he came complaining of pain under the operative scar on the right, with vomiting, and malaise of two days' duration. Examination showed tenderness under the scar but no tumor. Neither testicle was in the scrotum. At operation the testicle was removed and showed torsion.

Howard mentioned two cases of malignant tumor of the retained testis in which the appearance of the tumor was preceded by attacks of acute pain, which he thought were due to torsion.

5 CUPLER, in 1915, reported a case of torsion of an intra-abdominal testis which simulated acute appendicitis. The patient was a healthy man who had had no previous abdominal symptoms. The pain came on suddenly, was severe, and was followed by vomiting, rapid pulse, tenderness, rigidity in the lower right abdominal quadrant, elevation of temperature and a leucocyte count of 18,000. A diagnosis of either acute appendicitis or of torsion of an intra-abdominal testis was made. Operation showed a gangrenous testis with two complete twists to the cord.

OCCURRENCE AND ETIOLOGY OF TORSION OF THE CORD

The first report of a case of torsion was by Delasnuave in 1840. Operation was done for a supposedly strangulated hernia, and torsion of an inguinal testicle found. There followed at intervals isolated reports of cases until in 1901 Scudder reviewed the literature of the condition. Since then other cases have been added and reviews of the literature have appeared, by Rigby and Howard in 1907, Corner in 1907, Clute in 1919, O'Connor in 1919, Thorek in 1925 and Meltzer in 1926. In all about one hundred and fifty cases are on record.

It occurs most often in youth, at the age of puberty or in the first few years following, though there are several reports of instances at the age of a few days and a few at sixty or past. It has been observed at birth.

It occurs oftener on the right than on the left— $56\frac{1}{2}$ per cent in one series and $59\frac{1}{2}$ per cent in another. Incomplete descent with a developmental abnormality of the attachment of the cord to the testis seems to be the chief

predisposing cause In one series 69 per cent and in another 52 per cent were undescended testes It is probable that the failure to descend is only an indication of arrest of development A fully descended testicle is usually a fully developed testicle, but under certain circumstances, an incompletely developed testicle may be completely descended, and *vice versa* Since over half the recorded cases of torsion occurred in undescended testicles, it is easy to conceive that in the rest of them there was some developmental abnormality

The etiological factors given are 1 An abnormally loose scrotum 2 A voluminous tunica vaginalis 3 An unusually long gubernaculum 4 An abnormal attachment of the cord to the testis

From consideration of the anatomy and of the recorded cases the last two seem to be the most probable etiological factors Ordinarily the reflection of the parietal layer of the tunica over the epididymis forms a mesentery running from the globus minor up to about the middle of the globus major In most of the recorded cases of torsion this has been much shortened and includes only the globus major, and the twist has occurred in this very much shortened mesentery

A consideration of the mode of descent of the testicle and the occasional findings at operation on hernias of the infantile type will show how this abnormality can occur In operating on hernias of the infantile type, the epididymis is occasionally found more or less unravelled and attached to the testicle at the globus major only It can easily be seen how a shortened mesentery, as described above, could occur as the testicle pushes the peritoneum in front of it in the descent In such a case we would expect a long gubernaculum

Discussion—Including the case reported here, therefore, six cases of torsion of an intra-abdominal testicle have been found in the literature In three, the testis was the seat of a malignant tumor and in one of the others it had been previously replaced in the abdomen by operation In two, Cuplers and the one here reported, there was no complicating circumstance except the failure to descend In only one, Stiles, was there a definite diagnosis made before operation

It is interesting to note that in all the cases of torsion of an intra-abdominal testis reported, the right testicle has been the one affected This is not true of torsion generally, though the right is affected oftener than the left, just as maldescent, which seems to be the chief etiological factor in the production of torsion, is commoner on the right than the left

In one series of 77 cases of maldescent, in 39 cases the right alone was affected, in 23 cases the left alone, and in 15 cases the condition was bilateral So it is evident that maldescent in general is commoner on the right side, and the statistics of torsion of the testis correspond pretty well to these figures, occurring oftener on the right than on the left, but not oftener than could be accounted for by the more frequent occurrence of the malformation on the right But when we consider the statistics of abdominal retention and torsion a different story appears Abdominal retention seems to be nearly as common

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on the left as on the right, and yet no case of torsion of a left intra-abdominal testis has been reported. I am not prepared to offer an explanation of this, but it seems reasonable to suppose that the presence of the cæcum with its intermittent loading and pull on the peritoneum must have something to do with this.

BIBLIOGRAPHY

- Attlee *Lancet*, 1911, vol 11, p 761
 Babcock *Journal of American Medical Association*, vol lxvi, p 1699
 Barney *Urologic and Cutaneous Review*, 1922, vol xxvi, p 142
 Begg *British Medical Journal*, 1921, vol 11, p 843
 Butler *Surgical Clinics of North America*, 1923, vol 111, p 837
 Clute *Boston Medical and Surgical Journal*, vol clxxx1, No 8, p 232, With Bibliography
 Cohen, F *Munchen Medizinische Wochenschrift*, 1921, vol lxxviii, p 1668
 Corner *International Clinics*, vol 1v, 17th Series, 1907
 Cupler *Surgery, Gynæcology and Obstetrics*, vol xx1, p 250
 Dowden *British Medical Journal*, vol 1, 1905, p 932
 Fournier *Bulletins et Memoires de la Societe Anatomique de Paris*, 6th Series, vol xviii, p 377
 Gerster *ANNALS OF SURGERY*, vol xxvii, p 64
 Goings *Lancet*, vol 1, 1906
 Hagner *Transactions of the American Association of Genito-urinary Surgeons*, 1919, vol xii, p 185
 Hartmann and Renaud *Bulletins et Memoires de la Societe Anatomique de Paris*, 6th Series, vol xviii, p 257
 Hirsch *Zentralblatt fur Chirurgie*, March 14, 1925
 Howard *British Medical Journal*, 1907, vol 11, p 719
 Keyes, Collings and Campbell *Journal of Urology*, June, 1923
 Le Conte *International Clinics*, vol 1v, 17th Series, 1907
 Lynn *Bulletin of the University of Maryland*, vol 1v, No 5, p 199
 McKay *Surgery, Gynæcology and Obstetrics*, 1923, vol xxxvii, p 373
 Meltzer *Journal of Urology*, vol xv, No 6, p 601, With Bibliography
 Munay *British Medical Journal*, 1897, vol 1, p 458
 Nash *British Medical Journal*, 1921, vol 1, p 267
 O'Connor *Surgery, Gynæcology and Obstetrics*, 1919, vol xxix, p 580, With Bibliography
 Odione and Simmons *ANNALS OF SURGERY*, vol xl, p 962
 Parmenter and Counterman *Buffalo General Hospital Bulletin*, 1923, p 107
 Rigby and Howard *Lancet*, vol 1, 1907, p 1415, With Bibliography
 Rodd *Journal Royal Naval Service*, vol 11, 1921, p 79
 Scudder *ANNALS OF SURGERY*, vol xxxiv, p 234, With Bibliography
 Sonneland *Surgery, Gynæcology and Obstetrics*, vol xl, p 535
 Stiles *Transactions of the Medico-Chirurgical Society, Edinburgh*, 1905, vol xxv, p 5
 Taylor *British Medical Journal*, 1897, vol 1, p 458
 Thorek *Interstate Medical Journal*, vol xxvi, No 3, p 194
 Thorek *ANNALS OF SURGERY*, vol lxxx1, p 1142, With Bibliography
 Weitz *Deutsche Medizinische Wochenschrift, Leipzig*, 1923, vol xlix, p 381
 Williams *New York Medical Journal*, June 6, 1903

LATERAL VENTRAL HERNIA

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SPONTANEOUS ventral hernias are rare compared with the incidence of the inguinal, femoral and umbilical varieties. The epigastric type, in which the protrusion is through the linea alba is more common than lateral hernias outside the border of the rectus muscle. The great majority of these lateral hernias are found below the level of the umbilicus.

In spite of their relative rarity, ventral hernias have been recognized since the middle ages and have acquired a good-sized bibliography.

Guy de Chauliac distinguished between ventral and umbilical hernias. Astley Cooper ("Abdominal Hernia," 1807, and 2nd Edition, Philadelphia, Lea and Blanchard, 1844) gives as one reason for the occurrence of a hernia, the existence in the muscles and tendons of the abdominal wall of apertures for the passage of vessels and nerves, which, though naturally only large enough for that purpose, often become so relaxed as to allow the viscera themselves to protrude.

Discussing the situations in which abdominal hernias are found Cooper states, "Similar protrusions take place through the tendinous coverings of the anterior part of the abdomen. The linea alba and semilunaris are perforated to transmit vessels passing to the common integuments, when these holes are either originally of an unusual size, or are enlarged during a relaxed state of the body, hernias will occasionally be formed in them, which are called ventral." In addition to these apertures Cooper mentions as other causes for ventral hernia, defective development of the linea alba in children, wounds of the abdominal wall in the healing of which the muscles fail to unite, and a laceration of some of the fibres of the abdominal muscles under violent exertions or blows, which allows the peritoneum to pass between them. Of this last type he says, "I never however, have ascertained this by dissection, but am disposed to believe it, from the sudden appearance of the disease after a sensation of laceration."

The greater frequency with which lateral ventral hernias are formed below the level of the umbilicus lead Mohr (Bull et mem Soc Chir 1887, vol cx1, p 278) to suggest that the fold of Douglas determines the level of the protrusion. Macready ("A Treatise on Ruptures," London, 1893, p 258) insists that in spontaneous ventral hernia the protrusion is through aponeurotic lines or spaces rather than through muscular tissue.

The subject is more prominent in foreign than in American literature. Coley (ANNALS OF SURGERY, 1909, vol 1, p 246) reports a case. Cullen (J A M A, vol lxx, p 1251 and the "Umbilicus and Its Disease." Fig

* Read before the Southern Surgical Association, December 15, 1926

55) reports and illustrates a case in which the sac contained a multilocular ovarian cyst. Holloway (*ANNALS OF SURGERY*, 1922, vol lxxv, p 677) reviews the literature and gives a table of cases, as well as reports one of his own. Koljubakín (*Archiv für klinische Chirurgie*, 1925, vol cxxxvi, p 739) gives conclusions based on 30 dissections of the abdominal wall made to study the branches of the inferior epigastric artery as well as their relation to the aponeurosis of the transversalis and the sheath of the rectus. In addition he reports eight cases of lateral hernia and gives a historical study of the subject with an extensive bibliography.

The dissection showed arterial perforation of the linea Spigelii in about half the cases. Sixty per cent of these perforations were unilateral, and most of them occurred at or near the point where a line drawn from the anterior superior spine of the ileum to the umbilicus would cross the outer border of the rectus muscle. The size of the openings in the aponeurosis varies from 4 to 18 mm, in sixteen of the twenty measurements recorded the opening was between 3 and 7 mm.

Koljubakín describes the linea Spigelii as the boundary between the muscular and tendinous portions of the transversalis muscle, extending as a semilunar line from the level of the ninth or tenth rib to a point 2 cm lateral to the spine of the pubis. The convexity of the curve is outward and reaches a point 5 cm medial to the anterior superior spine of the ileum, on a line drawn from this bony prominence to the umbilicus. At the level of the tenth rib the semilunar line turns inward and fades out under the rectus muscle.

Holloway calls attention to the fact that there is no sharp line of demarcation at the junction of muscle and aponeurosis. The relative width of such junctions varies in different individuals. Therefore, the line of Spigelius is not fixed geometrically, but usually is represented by the outline described above. It would be better therefore to speak of the area between the outer border of the rectus muscle and the boundary described by Koljubakín as the semilunar space rather than the line of Spigelius.

A deposit of peritoneal fat is found between the serous membrane and the deep aponeurotic layer of the abdominal wall. A portion of this fat may penetrate one of the openings in the aponeurosis and pass through with the vessel. The collection of fat gradually increases in extent and finally forms a subperitoneal lipoma, one surface of which is firmly attached to the peritoneum while the remainder is through and outside the perforated aponeurosis. Gradually the movements of the oblique abdominal muscles make traction on the lipoma and this in turn draws a process of peritoneum after it through the aponeurosis to make a true hernial sac.

The hernia is an interstitial one lying between the transversalis and the oblique muscles. The pressure of large and long-standing irreducible hernias may thin the bundles of the overlying internal oblique to a degree of practical destruction, or the lipoma may spread the muscle bundles apart, but the firm aponeurosis of the external oblique is not perforated. The neck of the sac may be a long narrow tube passing obliquely through the opening in the

aponeurosis to connect the ring of protrusion with a vagrant fundus and properitoneal lipoma which forms a swelling at a considerable distance from the opening

When the opening in the aponeurosis and the lipomata are related in size the entire mass may be reducible. Sometimes the true hernial contents can be reduced, but the lipoma remains outside the transversalis aponeurosis. Often the entire hernia is irreducible and because of the narrow opening in the firm aponeurosis is prone to strangulation.

Atrophy and relaxation of the musculature of the abdominal wall from any cause as well as developmental anomalies of these structures are factors in the etiology of these hernias in addition to those associated with penetration by the vessels. Great increase in the fatty layers of the abdominal wall is an important factor, and often the hernia is noticed after such an adiposity undergoes atrophy.

In the earlier literature Spigelian hernias were reported as occurring more often in women than in men and repeated pregnancies were considered the responsible factor. Thirty-four cases collected by Koljubakín from reports during 1923 and 1924 were evenly divided between the sexes. The condition is one of middle life or later age. Most of the patients are beyond forty, many of them between sixty and seventy years of age at the time of onset of symptoms.

If the size of the hernia and its neck allows protrusion of a visible and palpable mass when the abdominal tension is increased and subsequent reduction of the swelling by manipulation, the diagnosis of a hernia is certain and the identification of the variety rests on the localization of the neck within the limits of the Spigelian area.

Small hernias and those in which the lipoma cannot be reduced offer difficulties in diagnosis. The lipoma and the small hernia may be impalpable in the thick abdominal wall. Localized pain and a persistent tender point may mark the seat of the hernia. When pressure at the tender point produces a gastro-intestinal reflex such as belching, nausea or cramps, the presence of a hernia should be suspected.

The symptoms of subacute and chronic appendicitis, cholecystitis, pelvic disease and renal colic may be confused with those of a cryptic hernia.

The absence of inflammatory phenomena as fever, leucocytosis, pain on distant pressure, and of muscle spasm and rigidity with the different clinical history of the diseases usually allows us to separate appendicitis and cholecystitis from these hernias. Cholecystography will aid in the recognition of the diseased gall-bladder. Similarly the urological and X-ray examinations will identify the kidney lesions and gynecological examination the pelvic disorders.

When the irreducible lipoma is the most prominent sign of the hernia, the diagnosis from other varieties of tumor of the abdominal wall is not always easy to make. The lipoma and hernia under pressure of the oblique muscles,

with certain reflex disturbances of digestion, may suggest a malignant tumor of the bowel

In spite of all our methods of examination and study certain of these hernias cannot be recognized. In such cases the persistent localized pain and tenderness, especially if these symptoms are intensified by exertion or the erect posture, justify an exploration of the region on the probability of finding a Spigelian hernia. When found, such a hernia requires for its cure, removal of the sac after closure of its neck, and repair of the opening in the aponeurosis and muscles by proper suture.

Following is the report of a hernia of the linea semilunaris Spigelii which came under my care at the Mercy Hospital in April, 1926. The hernia is one of the rarer variety situated above the umbilical line.

No 47,804. The patient was a white man, age fifty. Eight months before admission after playing a game of golf, he noticed a little puff on the left side of the abdomen which he thought became larger when his stomach was distended with gas. He was apprehensive concerning the possibility of a malignant tumor of the bowel. He was well nourished but not fat, and had not lost weight. On the left side of the abdomen, about an inch above the level of the umbilicus and two inches outside the border of the rectus muscle, there was a smooth, firm, immovable tumor, which was distinctly recognized as being situated under the external oblique muscle. The mass was not tender and manipulation did not cause pain. Except for this tumor the physical examination was negative. Laboratory examinations of the blood, urine and stools were negative as was an X-ray study of the gastro-intestinal tract. A diagnosis was made of fibroma of the abdominal wall situated under the external oblique muscle.

Operation, April 30, 1926. McGlannan.

Under ethylene anæsthesia an incision was made over the tumor. The external oblique was split in the direction of its fibres. The globular tumor, a fibro-lipoma about one and one-fourth inches in diameter, was found between the two oblique muscles. Connected with the deep surface of the tumor there was a tubular process of peritoneum about one-fourth of an inch in diameter, which went down between the muscular fibres of the internal oblique. These fibres were separated and retracted to expose the neck of the tube passing through an opening in the transversalis aponeurosis just at its junction with the fleshy bundles. Several small blood-vessels ran around the sac at this opening which was about one-half of an inch in diameter.

An adherent epiploica and a loop of large intestine could be seen through the translucent sac moving with each respiratory action. The sac was opened, the adherent bowel freed and dropped back. The neck of the sac was then closed with catgut and the remainder excised and removed with the lipoma. Each of the three muscle layers was sutured separately with catgut and the skin closed with equisatine. The patient recovered without any complications and has been relieved of his symptoms.

Greater consideration of the history of onset of the tumor might have led us to a correct diagnosis of lateral hernia, but the absence of any of the ordinary signs of hernia and the freedom from local pain and tenderness, with the presence of a firm immovable tumor did not suggest such a possibility to us.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held November 1, 1926

The Vice President, DR ASILEY P C ASHMEURST, in the Chair

FOREIGN BODY IN THE BLADDER

DR JAMES H BALDWIN reported the history of a man, aged twenty-two, who was admitted to the Methodist Hospital, March 22, 1925, with the history that for a year he had suffered with a severe bladder irritation, with

increasing frequency of micturition and marked dysuria. No history as to etiology could be obtained from the patient, although he was of course definitely aware of the cause. An X-ray taken showed a vesical calculus containing a foreign body (Fig 1a).

This was removed through a suprapubic incision. The patient made a prompt and uninterrupted recovery. The

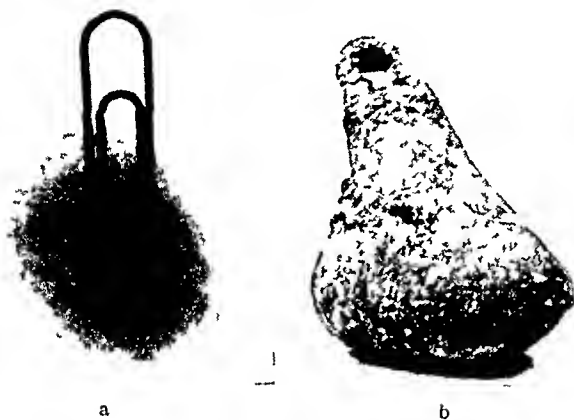


FIG 1a —Skiagraph of paper clip encrusted with urinary salts
b Encrusted paper clip removed from bladder

foreign body was found to be a paper clip encrusted with urinary salts (Fig 1b).

OBLITERATIVE ENDOANEURISMORRHAPHY FOR POPLITEAL ANEURISM

DR J STEWART RODMAN presented a man, aged fifty-six, who was admitted to the Presbyterian Hospital, May 6, 1923, complaining of swelling in left popliteal space.

About two years ago, patient first noticed swelling in left popliteal space about the size of a walnut, which has gradually increased in size. It was never painful until about a month ago, when walking home from work he was seized with cramp-like pains in leg. He went to bed for three days, but had had no pain for two weeks prior to admission.

Examination revealed a pulsating mass in the course of the popliteal artery. The blood Wassermann was negative.

May 10, 1926 —An incision about four inches long was made in the left popliteal space and the popliteal artery exposed. A small aneurism was found. The vessel was clamped above and below and the aneurism opened. A well-formed clot was removed and both ends of the aneurism obliterated. The wound was closed in the usual manner. Convalescence was complicated by a slight wound infection and a bronchopneumonia.

PERSISTENT SKIN ULCERATION IN AXILLA

Six weeks after the operation, the wound was clean, but the leg slightly swollen. This disappeared by the time of his discharge from the hospital, July 25, 1926, ten weeks after operation.

When seen three weeks ago, there was no further trouble with the leg and no intermittent claudication. The foot on the operated side was as warm as its fellow. The posterior-tibial pulse cannot be felt on the operated side.

PERSISTENT SKIN ULCERATION IN AXILLA

DOCTOR RODMAN presented a second patient, a man, aged thirty-three, who was admitted to the Womens College Hospital, July 23, 1924, complaining of a painful mass in left axilla.

Five months prior to admission he had an infected index finger of the left hand, which healed slowly. Five weeks prior to admission, he first noticed a small mass in left axilla, which gradually increased in size. Two weeks prior to admission the mass had been lanced in the dispensary. He stated that he had had blood poisoning in 1911, scarlet fever in 1915, electric burns of arms, hands and face in 1922, and occasional attacks of renal colic on the right side.

Examination revealed palpable lymph-nodes in the neck and inguinal region. There was an erythematous, irregular flush over the neck and upper part of sternum, but none on the chest or abdomen. Scars of old burns were present over both hands and arms, and the left arm was painful on motion. In the left axilla there was a non-fluctuating swelling, which was incised and a small amount of pus was evacuated and the wound packed with Dichloramine-T. Examination of blood revealed a polymorphonuclear leucocytosis with slight secondary anaemia. The blood Wassermann was negative.

Discharged to out-patient department on August 4, 1924, and made daily visits, until December 27, 1924. The lesion refused to heal completely. As it healed in one direction it spread in another, having resisted all treatment. He was readmitted on February 17, 1925. X-ray examination of the chest failed to show evidence of bone involvement around lesion in left axilla.

At this time the edges of ulcer were curetted and packed with iodoform gauze. The pathologist reported that the sections showed probable tuberculous granulation tissue. No evidence of pulmonary tuberculosis could be found. The affected area grew gradually larger, extending to the arm.

September 30, 1925, he was readmitted, the area cleansed, and wet dressings applied, and on October 2, 1925, the edges were again curetted and the entire area skin-grafted. A second pathological examination of curettings resulted in a diagnosis of tuberculosis of the skin.

When he was discharged November 19, 1925, most of the grafts were lost, but a few remained healthy. He was then referred to the dermatological clinic. Mercury and iodides were administered empirically but without effect. At the present time, the condition of the patient is substantially unchanged.

DR J. VICTOR KLAUDER remarked as to the pathology of this case that the pathologists did not agree to the diagnosis of tuberculosis. The consensus of opinion was that it was not a true picture of tuberculosis of the skin. Epithelioma can be ruled out clinically as well as histologically. Chancroid may also be ruled out. It fits best into that type of ulceration described by Sutton, of Kansas City, as tropical ulcer. Etiologically, it is variety of spirochætal infection, other investigators have found the spirochæte in this form of ulceration.

The study of these cases should always include a dark field examination and a histologic examination for spirochætes. There is also described a rapid ulcerative process.

The treatment of these cases is difficult. Neoarsphenamine should be used, it does serve a useful purpose, probably because some of them are infectious cases. In addition it is well to use general antiseptic and dietetic treatment. Another feature which was eliminated in diagnosis was granuloma inguinale. The question of a dermatitis self-produced was brought up, but there seemed to be no motive for such, and the man seemed to be emotionally normal.

DOCTOR RODMAN stated that in connection with Doctor Klauder's remarks concerning the fact that this case best fitted into that type described as tropical ulcer, it might be mentioned that the patient had just informed him that he spent fifteen years in the tropics—Panama and Colombia.

RECURRENT HÆMATEMESIS DUE TO SPLENIC ANÆMIA, APPENDICITIS AND CHOLELITHIASIS

DR DAMON B. PRELIER reported the case of a woman, aged thirty, white, American, who was admitted to the Presbyterian Hospital, July 1, 1926, with a typical attack of appendicitis which had begun the previous day. Fourteen months previously she had been referred to the reporter for an opinion on account of recurring severe gastric hemorrhages. She was then twenty-nine years old. The family history was negative. Except for mild scarlet fever and mumps her only indispositions had been occasional attacks of nausea and vomiting called bilious attacks. At times she thought she became yellow, but no definite history of jaundice was obtainable. Her digestion was good and she was considered the healthiest one of a large family. There was no history of malaria or suspicion of syphilis, later verified by a negative Wassermann. At the age of nineteen, without premonitory symptoms or known cause, she suddenly became nauseated and vomited a huge quantity of bright red blood and clots. This was repeated five times during several days and she became weak and anæmic. Recovery, however, was then rapid and she felt well, having no symptoms, digestive or otherwise. Since then at irregular intervals of several years she has had similar attacks of profuse hæmatemesis coming on without warning and persisting until she was almost exsanguinated, followed by rapid and symptomatically complete recovery. She never had had purpura but just before her first hemorrhage she says that she had a tooth pulled and bled profusely.

She was a well-nourished, healthy looking woman of clear complexion, not anæmic at this time and the abdominal examination was entirely negative. She was not again visited until she came into the hospital in this attack, fourteen months later, having been entirely well in the meantime.

At operation, which was performed immediately, he explored the upper abdomen before disturbing the region of the appendix. The gall-bladder was thickened and smaller than normal. The stomach and duodenum presented no abnormality to palpation. The spleen was markedly enlarged and extended down to, but not below, the costal margin. It was not deemed advisable to carry out any upper abdominal procedure at this time on account of the condition of the appendix which was gangrenous throughout and buried beneath the cæcum and ascending colon. It was evident that chronic disease had long antedated the acute attack. The appendix was removed, a drain

placed in the bed of the appendix, emerging through a stab-wound in the loin, and the anterior wound closed. The next day she vomited eight ounces of blood and thereafter continued to pass tarry stools for several days, becoming very anæmic and weak. Aside from hemorrhage, the abdominal condition was entirely satisfactory. The abdominal wound was healing by first intention and the drainage in the loin was moderate and of the usual fetid character seen in bacillus coli infections.

July 8 the blood count was as follows: Hb 30 per cent, red blood-cells 1,590,000, white blood-cells 15,850. July 12 she received a pint of blood by the citrate method and suffered a slight reaction a few hours later. Her convalescence after this was uneventful. She recovered rapidly. August 6 the blood showed Hb 45 per cent, red blood-cells 2,580,000, white blood-cells 4000. She was discharged August 8.

It was intended to have her return to the hospital later for cholecystectomy and splenectomy, with a view to obviating, if possible, further hæmatemesis. She was troubled slightly with indigestion, but continued to improve until September 3, 1926, when she was awakened at 3 A. M. by a desire to go to stool. She went to the bathroom, passed a tarry stool, and vomited a large amount of blood. In the next two days she had six severe hemorrhages. The following day she was brought to the hospital and was given 5 c.c. of thromboplastin, intramuscularly. September 5, she was given 500 c.c. of blood by the citrate method. No reaction followed but the day following she vomited about the same amount of blood that she had received. Two days later another small hemorrhage occurred following which there was no further hæmatemesis. At this time the blood count showed Hb 20 per cent, red blood-cells 1,270,000, white blood-cells 4400. She was again transfused without reaction. Following the cessation of hemorrhages, her recovery was rapid. October 15 the blood showed Hb 55 per cent, red blood-cells 2,850,000, white blood-cells 5300, coagulation time five minutes, bleeding time two and a half minutes. The following day, almost eleven years from the date of her first hemorrhage, the reporter removed the spleen and the gall-bladder. Another transfusion was given before she left the table. The spleen had increased in size, its lower border being three finger-breadths below the costal margin. There were no adhesions. The vasa brevia were large and thin-walled. The attempt to deliver the spleen in order to attack the pedicle from behind, ruptured some large vessels in the lienophrenic ligament and the attempt was abandoned, the bleeding being controlled by a gauze pack. The pedicle was then divided anteriorly in sections and tied and the organ removed without much loss of blood. It was noteworthy that all vessels, including those in the abdominal wall, showed an increased tendency to bleed. The torn vessels posteriorly were secured with a snaking suture. The gall-bladder was thickened and adherent to the duodenum and very atrophic. It was removed and the cystic duct tied. Both duct and gall-bladder contained pultaceous precipitated bile salts. The cystic duct was tied and an attempt made by suture to control oozing from the cystic fossa. The liver was so soft however, that this had to be abandoned. Oozing was controlled by pressure with a gauze pack for a few minutes. The operation was performed through a left rectus incision and a stab drain placed through the right rectus muscle into the cystic fossa. The liver was dark, congested, and as previously stated, unusually soft rather than cirrhotic. The stomach and duodenum showed no visible or palpable abnormality other than the varicosity of the vasa brevia above mentioned. The incision was closed without other drainage. Convalescence was uneventful.

The blood count, October 30, showed Hb 65 per cent, red blood-cells 3,310,000, white blood-cells 6600 Differential, polymorphonuclears 55 per cent, small lymphocytes 11 per cent, large lymphocytes 2 per cent, large mononuclears 11 per cent, eosinophiles 14 per cent, basophiles 4 per cent, megalocytes 4 per cent Poikilocytosis and anisocytosis, no normoblasts Reticulated cells 4 per cent, blood platelets 450,000 per c c

DOCTOR PIERRE remarked that the explanation of profuse gastric hemorrhage, and therefore the appropriate procedure to be used in treatment, are often difficult The pathology of certain types is sufficiently clear, such as the erosion of a vessel in the bed of an indurated ulcer, benign or malignant, or the rupture of an œsophageal varix Benign tumors such as myoma or polyp, while uncommon, may bleed profusely On the other hand, the source of the bleeding and reason therefore are not always apparent The descriptions of so-called mucous erosions are not convincing as an explanation of massive gastric hemorrhage and to most of us this conception seems scarcely more than a refuge when the actual source remains unknown as may well happen in the difficulties and dangers of complete examination under clinical conditions The "exulceratio simplex" of Dieulafoy seems better attested and there is no reasonable doubt that on occasions an acute gastric ulcer may open a vessel of sufficient size to provide alarming hemorrhage The roles of toxic states, infective or otherwise, of jaundice and blood dyscrasias, of coexistent disease of the appendix or gall-bladder in gastric hemorrhage are far from clear It is certain, however, that certain splenic enlargements are prone to be associated with gastric hemorrhage and in several fatal cases large varicose veins in the fundus of the stomach have been found post mortem, erosion into one of which veins has been the source of the hemorrhage It is not necessary that the liver be cirrhotic in all cases of varicose veins of the stomach In the case of splenic enlargement it seems probable that the greatly increased blood supply to the spleen results in a similar increase in that of the fundus of the stomach through the left gastro-epiploic which in time causes enlargement of the drainage veins of this area Presumably the hemorrhages of splenic anæmia are due to the ease with which superficial erosions of the gastric mucosa may open a vessel of considerable size Hence it is that such hemorrhages are apt to recur even after the spleen has been removed since the change in the venous channels must be permanent to a considerable extent That these cases are less often fatal than massive bleeding from callous ulcer may be due not only to the fact that in ulcer the vessel lies in fibrous tissue and is unable to retract or contract, but also because the bleeding vessel in ulcer is often an artery while in splenic anæmia it is a large venous channel containing blood under low pressure Splenectomy is the treatment of choice and in many cases has resulted in cessation of hemorrhages In late cases, however, bleeding often recurs During the stage of active hemorrhage operation is inadvisable and these cases rarely die of acute loss of blood unless their general health is depleted as in the later stages of the disease Supportive measures, with transfusion

GAS GANGRENE IN CIVIL SURGERY

if danger becomes acute, will usually bring the patient into condition for an interval splenectomy

DR JOHN B DEEVER remarked that he sees a number of these cases, only recently he operated upon a similar case where the only symptom was hæmatemesis. In his experience the hæmorrhages frequently recur even after ten or more years of supposed cure. A number of such cases have resulted fatally. He sees more liver changes, personally, than are reported in the literature and a small percentage with extensive ascites, this, however, does not prevent recovery after splenectomy. The condition, in his experience is not at all uncommon.

DR JOHN EIMAN demonstrated lantern slides made from colored photographs, of the specimens removed at the operation upon Doctor Pfeiffer's patient. The photographs were made by the new German process, which is somewhat similar to the lunear but which gives a much finer differentiation. The process is comparatively simple, and anyone familiar with ordinary photographic work can, with a little experience, prepare these color plates. It is impossible to reprint them on paper except by a three-color process, which is very expensive. The advantages of having a permanent and accurate record of this type are very great.

GAS GANGRENE IN CIVIL SURGERY

DRS JAMES H BALDWIN and WILLIAM R GILMOUR read a paper with the above title, for which see page 161.

DR JOHN EIMAN recalled two cases of gas gangrene which had occurred at the Presbyterian Hospital and had possibly been reported by Doctor Jopson.

One was a colored boy whose biceps was cut. The serum saved his life.

The second case was a case of ruptured appendix with localized peritonitis. Hypodermoclysis of salt solution was given and 24 hours later the patient developed gas gangrene at the site of puncture. The possibility of infection having been carried under the skin by the hypodermic needle was considered, but this could be eliminated. The literature disclosed the fact that German writers had reported similar cases. They have been able to prove definitely that these individuals had in their systems and possibly in their blood streams some of the gas bacilli and the needle produced trauma sufficient to start trouble.

DR THOMAS SHALLOW said that he had seen a case of this kind the year before last at the Blockley Hospital. The patient had a hypodermic syringe used at 9 P M and was dead at four the next morning from gas gangrene. The patient was under treatment for cardio-renal disease.

He recalled another case in the Philadelphia Hospital which would seem to be gas gangrene, from all the symptoms. The patient had a head injury, due to a blow from a foreign body. Gas gangrene developed. In neither of these cases was there any crushing injury, such as is usually described as preceding gas gangrene.

DR DAMON B PREIFFER remarked that he saw a case of gas gangrene several years ago following a hypodermic injection. The injection was given in the morning and in the middle of the day the gas gangrene infection was present. By four o'clock the patient was dead. He is particularly interested in the remarks made by Doctor Eiman. It was felt that some one in the hospital might have had something to do with the introduction of the infection. They never thought of the patient's having had the infection and the hypodermic injection merely being responsible for its localization.

SURGICAL PATHOLOGY OF THE GALL-BLADDER

DR V G BURDEN read a paper with the above title, for which see page 239.

DR JOHN B DRAVER said that biliary cirrhosis, the result of gall-bladder disease, should be mentioned. He recalled the case of a prominent Philadelphian who was operated upon for this condition. He is now seventy years of age, and is better than he was ten years ago, before he had any trouble. This is the result of prolonged common duct drainage.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held November 10, 1926

The President, DR WALTON MARTIN, in the Chair

LATE RESULTS FOLLOWING PARTIAL GASTRECTOMY FOR CARCINOMA OF THE STOMACH

DR RICHARD LEWISOHN presented two patients upon whom he had operated for carcinoma of the stomach at Mount Sinai Hospital ten and seven years ago. The first patient, now sixty-five years old, was admitted to the surgical service ten years ago. He had complained about epigastric distress for two months and had lost thirty-five pounds. The hæmoglobin was 41 per cent. X-ray examination demonstrated a large pyloric carcinoma. The test-meal showed free HCl absent, blood present, Boas-Appler bacilli present. On exploration a large pyloric carcinoma was found which was adherent to the pancreas, but did not invade this organ. A partial gastrectomy with Murphy button gastro-enterostomy was performed. Pathological report showed colloid adenocarcinoma.

The patient developed an empyema three weeks after the operation. The empyema was drained through an intercostal incision under local anæsthesia. After this secondary operation the recovery was uneventful. The patient returned to his original occupation (conductor) and he is still active in this profession at present. He has gained sixty pounds since his operation, ten years ago, and is in perfect health.

The second patient, now seventy years old, complained of epigastric distress for four months before his admission in 1919. The operation revealed a very large indurated mass, occupying about three-quarters of the stomach in its whole circumference. A subtotal gastrectomy with Murphy button gastro-enterostomy was performed. Microscopical examination showed carcinoma solidum.

The patient has been in perfect health since this very extensive resection seven years ago.

DOCTOR LEWISOHN stated that he was well aware of the fact that recurrences usually followed operations for carcinoma of the stomach after a comparatively short interval. For this reason many surgeons hesitate to advise operation, especially in the presence of large tumors. However, occasional radical cures, such as those presented herewith, make it imperative to attempt a removal of the tumor, as long as the growth is still confined to the stomach.

While the Murphy button is rarely used at present, the results obtained in these cases demonstrate that this little instrument should not be entirely discarded, as it simplifies the anastomosis in very extensive resections.

CARCINOMA OF SPLENIC FLEXURE OF COLON

DOCTOR LEWISOHN presented a man, who was admitted to the medical service of Mount Sinai Hospital on December 15, 1922. He was twenty-seven years old at the time of his admission. He gave the following history. Ten

months ago he had suffered from rectal bleeding on three occasions, and a surgeon had performed a hemorrhoidectomy. Eight weeks ago he noticed pain in the left upper quadrant. Two weeks ago he had some chills and three days ago he noticed tarry stools. His temperature during the observation period on the medical service ranged between 101 and 102. Palpation revealed a hard, tender mass in the left upper quadrant. X-ray examination showed a constriction at the junction of the transverse colon and splenic flexure.

He was transferred to the surgical service. Operation through an incision along the left costal border revealed a hard mass in the splenic flexure. After the peritoneal cavity had been protected by packings, a pericolic abscess was entered, containing one ounce of pus. The abscess cavity communicated with the lumen of the colon. The tumor was densely adherent to the anterior abdominal wall and the diaphragm. These adhesions were divided. The gastro-colic ligament was then ligated and the blood supply of the splenic flexure tied off. A Mikulicz "vorlagerung" was performed in typical fashion and the incision was closed, allowing ample room for drainage.

The tumor was removed two days following the operation. Microscopical report: adenocarcinoma. The patient made an uneventful post-operative recovery. The spur was crushed on January 22, with the use of Stetten's enterotribe. Four weeks later an extraperitoneal closure of the artificial anus was effected and the patient was sent home March 21 with the fistula practically closed.

One month after his discharge from the hospital a number of abscesses formed around the fistula and the colostomy broke open again, most of the stools passing through the colostomy.

He was re-admitted October 6, 1923. An intraperitoneal closure of the colostomy was performed which healed by primary union.

He is now in perfect health, four years after the operation, and has gained fifty pounds.

DOCTOR LEWISOHN stated that he presented this patient in order to show that in spite of the fact that carcinoma is usually of a most malignant nature in young individuals, excellent results can be obtained occasionally by radical removal of the growth.

The second patient, sixty years old, was admitted to the surgical service of Mount Sinai Hospital, September 13, 1924. He had suffered from an incomplete obstruction three months previous to his admission. The attack lasted for three days. His symptoms recurred September 11, 1924.

Examination revealed a slightly distended abdomen without visible peristalsis. On the day following his admission he had marked cramps and vomited. X-ray enema showed an incomplete obstruction at the splenic flexure and marked dilatation of the transverse colon.

Operation—September 15. The abdomen was opened through an incision along the left lower border of the ribs. A small scirrhous carcinoma was found at the splenic flexure. The proximal colon was markedly dilated, the distal colon was collapsed. A Mikulicz "vorlagerung" was performed. Closure of the incision in layers. The tumor was resected with the aid of a cautery ten days after the operation.

A microscopical examination could not be made, as the resected gut was completely gangrenous.

The patient made an uneventful recovery and left the hospital on October 11. He was readmitted for a few days for division of the spur with the aid of an enterotribe. An extraperitoneal closure of the colostomy was effected by Doctor Klein in January, 1915.

RESECTION OF SIGMOID AND BLADDER FOR CARCINOMA

DOCTOR LEWISOHN stated that while he favored primary resection in the absence of obstructive symptoms, the Mikulicz "vorlagerung" should be the method of choice in any case showing signs of obstruction

RESECTION OF SIGMOID AND BLADDER FOR CARCINOMA WITH FIVE YEAR CURE

DR DEWITT STETTEN presented a woman, sixty-five years of age whom he first saw with Dr Otto Hensel December 3, 1921 She gave a history of

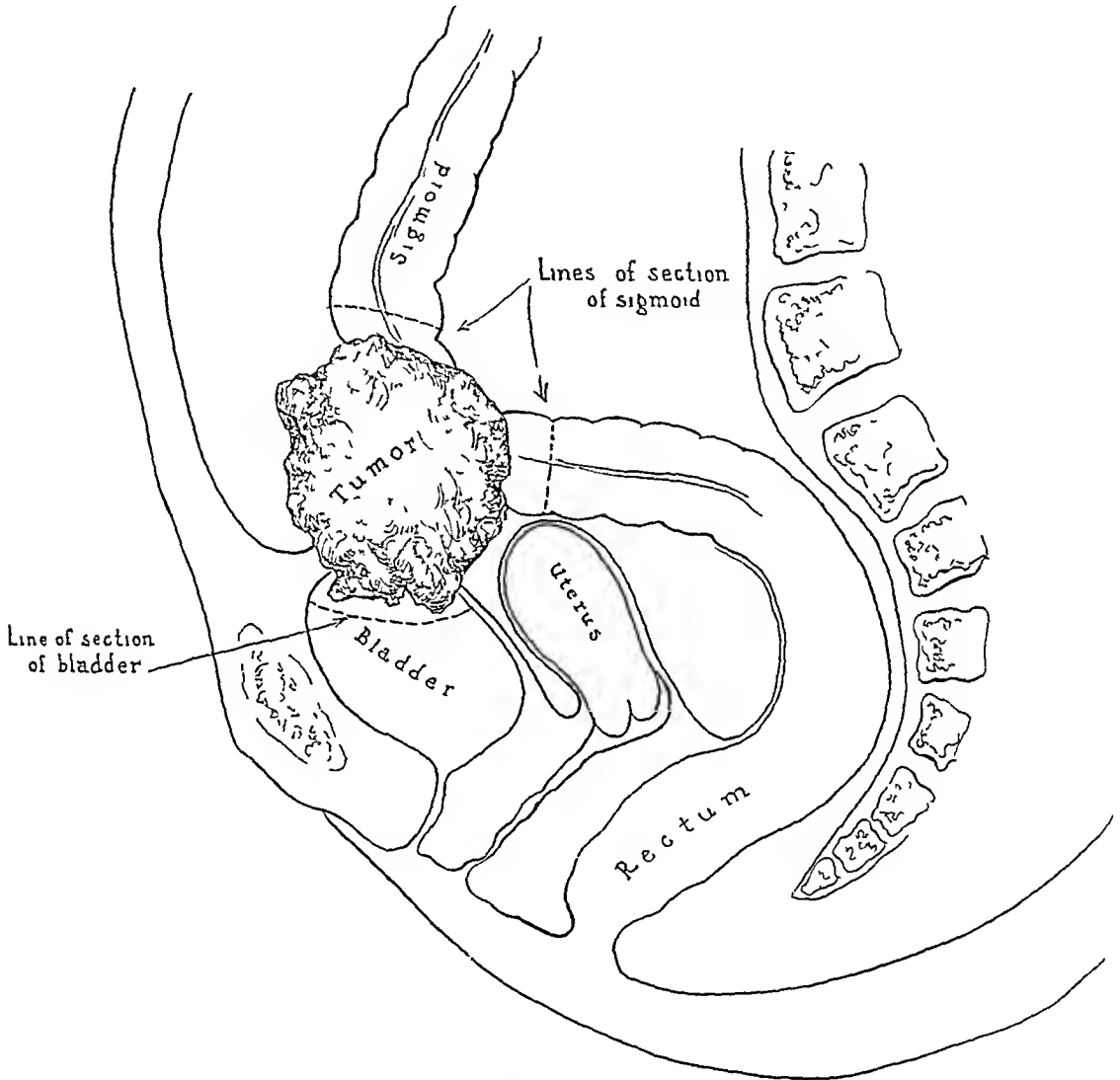


FIG 1—Diagram showing relations of adenocarcinoma of sigmoid involving bladder, and lines of resection

having been passing blood in her urine for a short time She had had no symptoms referable to her intestinal tract A cystoscopy had been performed by Dr Herman R A Graeser which showed a large, ulcerating tumor, obviously a carcinoma, at the posterior wall of the bladder near the vault On abdominal examination a hard, irregularly spherical, rather fixed mass, about the size of a small orange, could be felt just above the symphysis, which could be easily palpated bimanually Her urine was red and cloudy and showed a large quantity of blood and pus On December 6, 1921, on the assumption that the lesion was a large ulcerating carcinoma of the vault of the bladder, a suprapubic cystotomy was performed through the anterior wall of the bladder, and a large, friable, ulcerating area exposed on the posterior wall of the bladder near the vault It was soon seen, however, that

this tumor extended intra-abdominally behind the bladder, and further, that fecal material entered the bladder from the ulceration. The abdomen was opened. It was now seen that the tumor was obviously a large primary neoplasm of the sigmoid attached to the posterior wall of the bladder near the vault and perforating into this organ (Fig 1). Although the operability of the tumor was questionable, a wide elliptical excision of the posterior wall of the bladder was then performed well beyond the invaded area and both the posterior wall defect and the anterior superior suprapubic opening were closed in the usual manner, leaving a somewhat conical bladder after suture. The tumor, which was very adherent to the adjoining tissue was freed with considerable difficulty, a typical resection of the sigmoid well beyond the neoplasm, with end-to-end anastomosis by suture was then done. Good approximation with a satisfactory lumen of the gut was obtained and the mesenteric defect was closed. The usual drainage was introduced and the abdominal wound was sutured. An indwelling catheter was placed into the bladder. Examination of the specimen showed it to be a large, ulcerating, papillary tumor of the sigmoid, invading the entire lumen and perforating at a point opposite the mesentery of the intestine and invading the bladder for an area of at least one and a half inches in diameter. There was only very slight stenosis of the lumen of the gut. No mesenteric glands could be found. Microscopical examination by Dr. Frederick D. Bullock showed the tumor to be an adenocarcinoma of the sigmoid with extensive involvement of the bladder.

The patient had a rather stormy convalescence. There was considerable sloughing of the wound and a urinary fistula developed. About two weeks after operation a fecal fistula developed, but, however, this was apparently from the small intestine judging from the character of the discharge, the absence of flow into the fistula upon rectal irrigation, and the fact that ingested food soon appeared at the fistula. This fistula was probably due either to the infection or to erosion of the small intestine from the drains. Neither fistula showed any tendency to close in spite of every effort at treatment. The patient ran down very rapidly and the skin around the wound became greatly irritated in spite of the greatest possible care. Pain developed over the pubis especially on the right side, and X-ray examination showed some fuzziness, mottling and loss of detail of both pubic bones which Dr. William H. Stewart regarded as characteristic of carcinomatous metastases. In spite of this discouraging report from the roentgenologist, on April 12, 1922, reoperation was undertaken to close both fistulae and to inspect the pubic bones. Under general anaesthesia the old scar was excised around the fistulae and all granulation tissue thoroughly curetted out. The pubic bones both showed evidence of disease, particularly the right. They were soft and there were several loose spicules of necrotic bone found. The diseased bones were thoroughly curetted and more soft necrotic bone with considerable granulation-like tissue was removed. This condition of the pubic bones resembled more an infectious condition by direct extension from the wound, than a neoplastic invasion. The opening of the fecal fistula was exposed and the peritoneal cavity opened. The fecal fistula was found to arise from a loop of ileum which was very densely adherent to the abdominal wall. This intestinal loop was loosened and the fecal fistula closed in the usual fashion. Other adherent intestinal loops were freed. The opening in the bladder was now carefully exposed, freed and closed in the usual manner by a double layer of chromicized catgut sutures and a flap of peritoneum was laid over the suture line. No opening could be found at the sigmoid suture but this region was densely adherent to the posterior wall of the bladder, although

RESECTION OF SIGMOID AND BLADDER FOR CARCINOMA

there was apparently no communication between the gut and the bladder. This area was not disturbed. Drainage was inserted, the wound closed in the usual manner, and a permanent catheter was left in the bladder. Microscopical examination by Dr. Frederick D. Bullock, of the tissue removed by the curette, showed it to be suppurative granulation and inflammatory fibrous tissue with no evidence of carcinoma. Two days after operation there was a slight leakage of urine along the abdominal drains, apparently because the catheter had become clogged. After the catheter was cleaned the drainage of urine from the wound greatly diminished. Twelve days after operation the wound was granulating nicely, and there was no evidence of fecal or urinary leakage. One month after operation the catheter was withdrawn. There was no sign of either urinary or fecal leakage from the wound which was rapidly closing. Immediately after the withdrawal of the catheter, patient held her urine from two to three hours, passing from two to four ounces of clear urine at a time. She was discharged from the hospital, May 16, 1922, weighing eighty-eight pounds. Within a month the wound was entirely healed and the patient steadily began to improve. The patient feels perfectly well today. She has had no symptoms referable to either her intestine or her bladder since. There is no particular frequency of urination and she voids normal quantities of clear urine. Abdominal examination shows a fair sized, post-operative ventral hernia at the lower angle of the hypogastric wound. Vaginal and rectal examination are negative. There is no evidence of recurrence. She now weighs 147 pounds, which is seventeen pounds heavier than her normal weight before the operation.

This case demonstrates the relative benignity of certain types of colon carcinomata, and is a plea for radical surgery even in cases that apparently border on inoperability.

Dr. JOHN DOUGLAS remarked that there is a great deal of pessimism existing as to the end-results of operation in carcinoma of the stomach, but the difficulty lies in the fact that most of these cases do not appear early enough to get good results, and probably never will. The speaker was doubtful if it was possible to tell from the gross pathology in which cases recurrence was most likely to happen, and he agreed with the doctrine that so long as there is a chance, it is worth while to operate radically on these patients. He remembered one case in which there had been a visible, palpable tumor for over a year and the patient lived for nine years after operation, and was then lost track of. He remembered too, a large number of patients who lived five years and more, two or three being still alive seven and eight years after sub-total resection. On the other hand, he recalled cases, one of which he had operated on a year ago, in which the tumor was so small one could not distinguish it from an ulcer, which had recurrence in the neighboring glands of the stomach within a year.

Dr. GEORGE WOOLSEY referred to his report of two advanced cases in which the results of operation surprised and gratified him, one living and well thirteen years and the other ten years after operation. Not only that, but in cases where a permanent or a long recovery cannot be expected there are often unexpectedly good results. He remembered one old man with a tumor as large as an orange who begged for an operation and who lived for two years after operation, in perfect comfort for twenty-one months although he

finally died of recurrence in the liver. He gained one and three-fourths years of normal comfortable life.

NEUROLYSIS FOR CICATRICIAL STRANGULATION OF MUSCULOSPIRAL NERVE

DR DEWITT STETTEN presented a man, age twenty-two years, who was first seen March 7, 1922. He had been working in a wire factory and on November 3, 1921, while operating a wire-winding machine, an accident occurred which resulted in the wire winding itself tightly around his right arm just above the elbow. The arm was not fractured nor was the skin even cut, but a deep furrow formed. For a few days he was not able to use the arm, but there was no immediate numbness or paralysis and he even returned to work about a month after the accident. Two months after the accident, on January 9, 1922, he first noticed a numbness of the thumb and the adjoining region of the dorsum of the hand, and two days later, on January 11, 1922, a wrist drop developed. The paralysis of the extensors of the wrist and proximal phalanges rapidly became complete and showed no tendency to improve. On March 4, 1922, he was examined by Dr. George W. Jacoby, who established the presence of a total musculospiral paralysis below the branch innervating the supinator longus with the characteristic motor and sensory paralyses and with reaction of degeneration present both on stimulating the muscles and nerve. Conditions of the paralyses were unchanged when he was seen by the reporter. There was absolutely no trace of active motion in the wrist, the extensor ossis metacarpi pollicis, or the proximal phalanges. There was a deep circumferential furrow about an inch above the right elbow, and at the point where this furrow crossed the musculospiral nerve there was a somewhat sensitive nodule. X-ray examination showed a faint line indicating the furrow in the soft parts, but there was no evidence of bony injury. Patient was operated on, March 13, 1922, under general anaesthesia. An incision was made along the outer edge of the biceps at the lower third of the arm, extending down the forearm. After the skin had been divided, a dense transverse scar was found. The biceps was pulled inward and the musculospiral nerve exposed above the scar area. The nerve was seen to run directly under the scar, which apparently bound the nerve tightly against the bone. The scar was gradually and carefully divided until the nerve was entirely free. It was found that a deep furrow had been made in the nerve by the compression of the scar and the proximal end of the nerve was slightly swollen. It was apparent that the nerve was not divided, but on palpation it was found that the nerve tissue had been seriously damaged by compression so that only rather a thin area was left between the proximal and distal portions. At the time it was assumed from the results of palpation that very few of the nerve fibres were left undamaged, and that the nerve was held together mainly by the sheath. The damaged area was below the point from which the branch of the supinator longus was given off, and when this branch was irritated by pinching with the forceps, there was a distinct contraction of the supinator longus. The wound was closed and the hand and wrist put up in a cock-up splint. Thirty-six hours after operation the patient was able to extend the wrist slightly. Within the next week there was very rapid improvement in extension of the wrist, and eleven days after operation, patient could not only extend the wrist rather well, but could also extend somewhat the extensor ossis metacarpi pollicis and the proximal phalanges, and the extensor muscles of the forearm began to react weakly to Faradism. The area of anaesthesia had not changed. Five weeks after

ENTERO-ENTEROSTOMY

operation the extension of the wrist and fingers was almost normal and the area of musculospiral anæsthesia had completely disappeared. About a month later the function of the extensors of the wrist, the thumb and the proximal phalanges of the fingers was practically normal, both as regards motion and power. All electrical reactions were likewise normal. The fuliow above the elbow has persisted, but does not seem to cause any serious trouble except possibly slight weakness in the biceps.

This case shows the occurrence of a late musculospiral paralysis from compression of a cicatrix after only soft part injury. It is presented, however, mainly to illustrate that after a serious lesion of a nerve, with total paralysis and even reaction of degeneration almost immediate beginning recovery can take place after the cause of the nerve disturbance is removed. Most of the writers on injuries of the peripheral nerves admit this possibility. He thought it to be extremely doubtful if this can occur if there has been an actual division of the nerve, but that it can occur after a cicatricial strangulation is released by neurolysis is definitely illustrated by this case.

ENTERO-ENTEROSTOMY SEVEN YEARS AFTER GASTRO-ENTEROSTOMY

DR DEWITT STETTEN presented a woman, age fifty-three years, who was first seen with Dr. Max Einhorn on May 20, 1926. The essential fact in her history was that she had been a sufferer from stomach trouble since her first pregnancy, twenty-eight years ago, with epigastric distress and occasional vomiting after meals. In 1903, she had a ventral suspension and appendectomy performed. She was under more or less constant treatment until April 8, 1919, when she was operated on in Chicago, presumably for a cicatricial benign stenosis. A posterior retrocolic gastro-enterostomy was performed. After the operation the patient evidently had a rather persistent vicious circle. She vomited for nine weeks and was given gastric lavage twice daily. After that she gradually began to improve, but never gained much in weight, her best weight for the next two years being ninety-seven pounds. She gained weight, thereafter, and went as high as 110 pounds about six months ago. She remained fairly well with only occasional attacks of indigestion and vomiting after a dietary indiscretion until January, 1924, when she had a very severe attack of acute right upper abdominal pain, lasting five hours, with vomiting. She became decidedly jaundiced and the urine was very dark. She also had a slight rise of temperature. This attack subsided after ten days, and for the past two years she has been fairly well except for occasional sensation of pressure in the upper abdomen after eating. Her present illness began May 10, 1926, with a slight attack of right upper abdominal pain. In the ten days before she was seen by Doctor Stetten, she had repeated attacks of pain in the right hypochondriac region varying in severity and lasting from one-half to five and a half hours. In some of the attacks the pain radiated to the back and shoulders and some were so severe that morphine was required. She became slightly jaundiced and vomited during the severer attacks.

The patient was a rather thin, undernourished woman. She was distinctly though slightly jaundiced. There was a solidly healed median hypogastric and long upper right rectus scar. There was distinct sensitiveness in the right hypochondrium and slight rigidity, definitely increased by deep inspiration. Temperature was normal. The leucocyte count was 17,800, with 90 per cent polymorphonuclears. X-ray examination showed a distinct round, mottled shadow at the upper free border of the liver, suggesting a large thickened wall gall-bladder containing multiple calculi. Administration of tetra-iodo-

phenolphthalein showed no increase in the density of this shadow, indicative of an obstruction to the cystic duct

With the diagnosis of subacute cholecystitis and cholelithiasis with multiple calculi in the gall-bladder and a calculus impacted in the cystic duct or at the junction of the ampulla of the gall-bladder and the cystic duct, operation was performed under general anæsthesia May 24, 1926. Through a long right hypochondriac incision through the rectus, a very large, tensely distended, much injected, purplish gall-bladder, fully the size of a large pear,

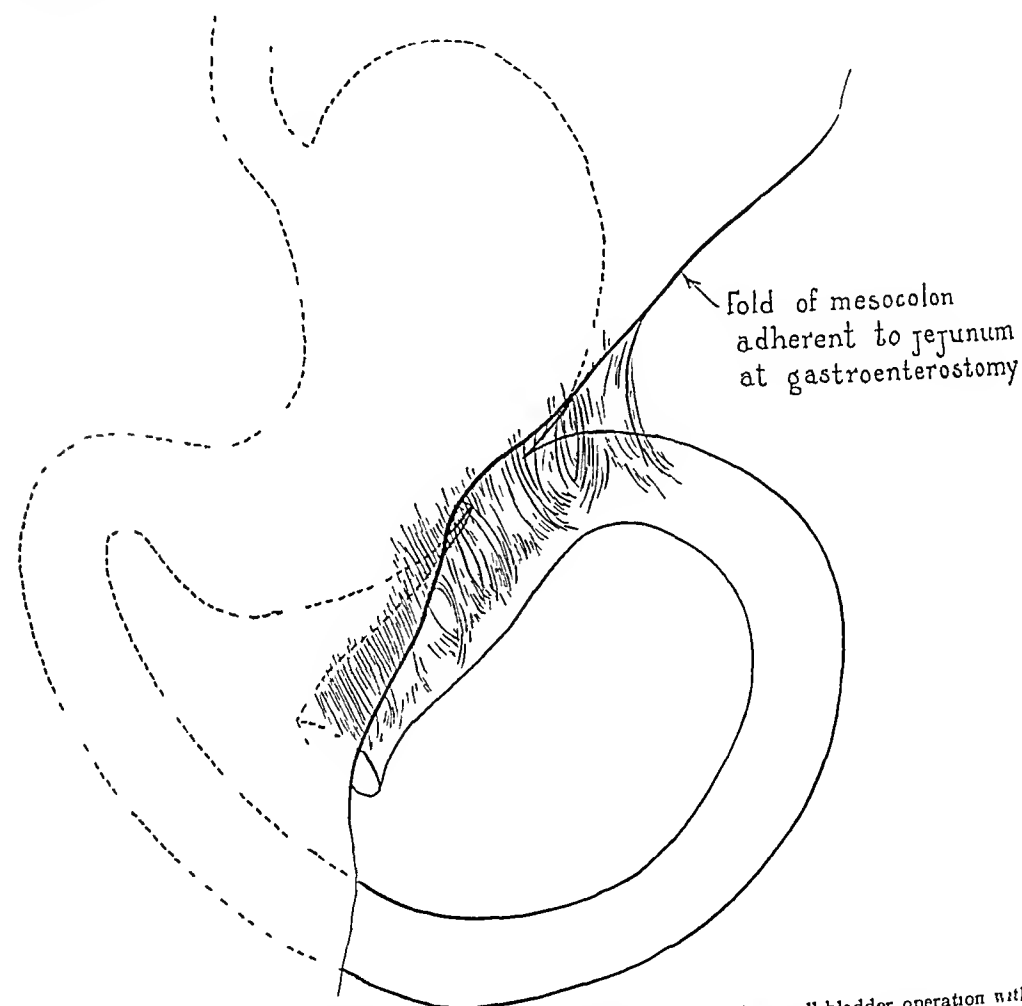


FIG 2 —Diagram representing condition of gastro enterostomy observed at gall bladder operation with fold of mesocolon adherent to jejunum at gastro enterostomy particularly to efferent loop

was exposed. There was a large calculus impacted at the junction of the ampulla of the gall-bladder with the cystic duct, and when this was milked upward and the gall-bladder tension somewhat diminished by expression, numerous calculi could be felt in the gall-bladder itself. No calculi could be felt in the common bile duct or at the papilla of Vater. A typical cholecystectomy from above downward was done and a double ligature applied to the cystic duct stump which was cauterized. There was no evidence of ulceration, cicatrization or tumor in the stomach, pylorus or duodenum. The pylorus was widely patent and the index finger could be easily invaginated into it from both the gastric and duodenal sides. The gastro-enterostomy was next examined, which was found to be of the posterior retrocolic type. The anastomosis had been made with a comparatively short loop running

from left to right and was placed near the greater curvature of the stomach at about the junction of its middle with its pyloric third. The stoma was about one inch in diameter. The edges of the stoma could be felt distinctly. They were smooth and there was no evidence of ulcer, either in the stoma or in the jejunum. The mesocolon was adherent at the anastomosis, particularly at the beginning of the efferent loop, which seemed to be surrounded by a portion of the folded mesocolon (Fig 2). These adhesions around the gastro-enterostomy were partially separated, but only sufficiently to expose the anastomosis to thorough inspection and palpation and to establish the fact that the loop was running in the proper direction and not kinked. It was deemed inadvisable to make a complete exposure, particularly as the adhesions of the mesocolon surrounding the beginning of the efferent loop were rather vascular and inasmuch as it was felt that nothing was to be gained by entirely freeing the fold of mesocolon from the intestine. A cigarette drain was introduced past the cystic duct stump to Morrison's pouch and the abdominal wall was closed in the usual fashion. The gall-bladder showed the characteristic changes of a subacute cholecystitis, which was confirmed by microscopical examination. It contained a large quantity of thin, somewhat turbid, yellowish-brown, biliary fluid, and twenty-five fair-sized, angular, faceted, dark blackish-brown, rather friable calculi, varying in size from a pea to a hazelnut kernel and numerous small black particles, either pieces of larger or newly formed smaller calculi. The cystic duct was quite narrow, barely admitting the passage of a probe.

The patient showed rather more than usual shock from the relatively simple operation. She had the usual post-operative vomiting which ceased after thirty-six hours, when she also began to react very satisfactorily as regards her general condition. On the fifth day she had a good result from an enema. On the sixth day she seemed to be making a very satisfactory convalescence except that she belched a good deal and complained of some gastric distress. In the evening of that day she was very nauseated and began to vomit biliary fluid. In spite of frequent lavage, which showed extreme retention, this vomiting of darker biliary fluid plus practically everything ingested, persisted, and June 4, 1926, a consultation was held with Dr Max Einhorn and Dr Joseph A. Blake, when it was agreed that the patient was probably suffering from a recurrence of a vicious circle due to some disturbance at the old gastro-enterostomy. Observation was agreed upon and the usual measures for counteracting the dehydration were instituted. Several unsuccessful attempts were made to feed her by means of the duodenal tube. Marked acetoneuria developed. An indefinite sensitive resistance could be felt in the lower epigastric and left hypochondriac regions. Three further consultations were held and although the patient had a few bowel movements, her vomiting persisted, and on June 7, 1926, two weeks after the cholecystectomy, reoperation was decided upon. In spite of the incessant vomiting her condition had remained very fair, but, nevertheless, a transfusion of blood was given as a precautionary and preparatory measure. While the patient was being scrubbed up on the table, for the first time definite visible gastric peristalsis was noted. Under a light general anaesthesia a longitudinal median epigastric laparotomy was made. An enormously dilated stomach, including the first portion of the duodenum, and with an obviously patent pylorus, was seen. The stomach filled the entire upper two-thirds of the abdomen. The stomach wall was congested and hypertrophied. A dense longitudinal band of adhesions of the duodenum, colon and omentum to the right hypochondriac scar closed off the site of the cholecystectomy. There was a slight fibrous exudate on the transverse colon. It was imme-

diately seen that nothing could be done without emptying the stomach, and a longitudinal gastrotomy incision was made in the anterior wall in the prepyloric region. Some air escaped immediately and about one thousand c c of thin bilious fluid containing milk curds was aspirated from the stomach and duodenum. The stomach now collapsed completely and the gastrotomy wound was closed in the usual fashion. The transverse colon could now be lifted up. The transverse mesocolon was densely infiltrated, shrunken and tightly plastered by dense adhesions to the region of the gastro-enterostomy.

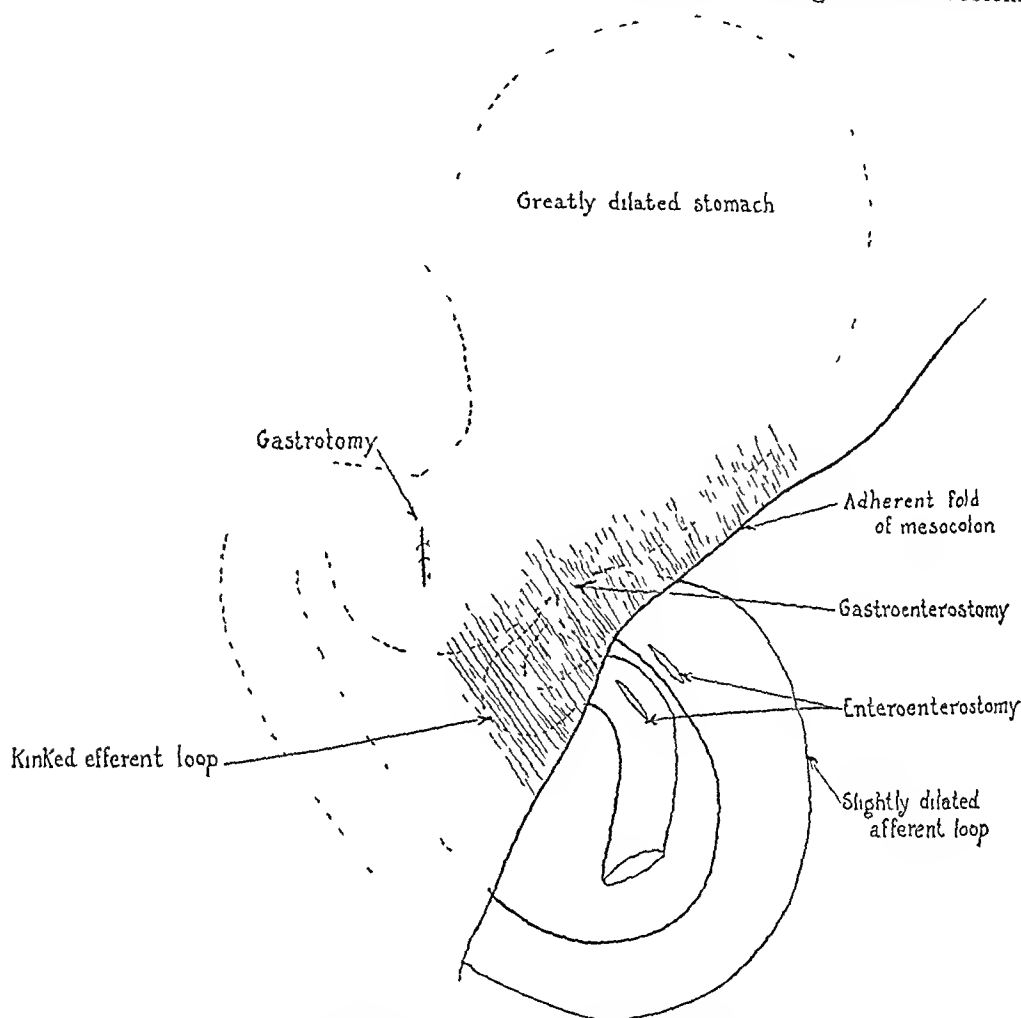


FIG. 3.—Diagram representing condition found at second operation showing and fold of mesocolon densely adherent below gastro-enterostomy with some and marked kinking of efferent loop. Location of gastrotomy and entero-entero-

but considerably lower down than at the first operation. Emerging from underneath the edge of the fold of transverse mesocolon were two definite intestinal loops running more or less parallel in the long axis of the body. The one lying to the left was somewhat dilated and friable and seemed to be the proximal loop of the gastro-enterostomy, apparently somewhat shorter than appeared at the previous operation. The right loop was somewhat smaller than the left but not actually collapsed. It ran downward and to the right and was apparently the efferent loop of the anastomosis. It was felt that separation of the adhesions and direct exposure of the gastro-enterostomy would be an inadvisable procedure, and a lateral entero-enterostomy between these two loops was decided upon. This was proceeded

with by suture When the intestinal loops were opened it was seen that the left loop contained thin bilary fluid similar in character to that which had been previously aspirated from the stomach, and that the right loop was empty, proving that we were dealing with the correct loops of the gastro-enterostomy A finger inserted into the left loop entered the stomach about one inch and a half above the edge of the adherent mesocolic fold The gastro-enterostomy opening seemed to be somewhat narrower than had been assumed at the previous operation, just admitting the tip of the examining finger With the finger in the afferent loop no connection with the efferent loop could be felt Inserting the finger into the right loop a definite angulation could be recognized which turned toward the gastro-enterostomy opening, but the gut was so kinked off that the finger could not actually be inserted into the stomach from the right loop (Fig 3) The entero-enterostomy was completed in the usual manner, leaving a very satisfactory anastomosis about one inch in diameter, and the abdominal wall was closed in the customary fashion The operation was very well borne by the patient and the usual methods of stimulation and fluid administration were instituted Eighteen hours after the operation the patient presented a most satisfactory appearance She had not vomited since the operation and her nausea had completely disappeared She was quite cheerful and already gave the impression that she was on the road to recovery Aside from small superficial abscesses developing in both the right hypochondriac and median epigastric wound, which healed promptly after evacuation, her convalescence was entirely uneventful For a short time there was some bilary drainage from the gall-bladder wound She took gradually increasing quantities of nourishment and never vomited again Since her discharge from the hospital she has been eating practically everything, gaining steadily in weight, and aside from occasional flatulence after a dietary indiscretion, she is entirely free from abdominal pain or gastric symptoms In fact, her stomach condition is much better at the present time than it has been in the past twenty-eight years, and she now weighs 116 pounds, which is five pounds heavier than her best weight in that period

This case is presented primarily to demonstrate the possible menace of a gastro-enterostomy to a patient who is subjected to a subsequent laparotomy, particularly if that gastro-enterostomy has been performed primarily without proper indications, and if some defect in the position or formation of the anastomosis renders it susceptible to a recurrence of trouble As regards this woman, it is possible that her original symptoms were largely the result of her gall-bladder pathology which, according to her history, probably began, as so frequently happens, during or just after her first pregnancy, and that the gastro-enterostomy performed seven years ago was never really indicated Of course it might be argued that if the gastro-enterostomy had never been inspected at the gall-bladder operation, the dense adhesions with the kinking of the efferent loop might never have developed, but having the abdomen open, it was not only a pardonable but even a justifiable curiosity which prompted the examination of the pylorus and the gastro-enterostomy to determine their present status

DR JOHN DOUGLAS said that he had encountered just such a condition as a post-operative complication, in which there was a mechanical kinking or narrowing of the distal loop due to adhesions, in which case an entero-enterostomy had not availed to relieve the symptoms as in Doctor Stetten's patient If the obstruction is in the proximal limb, the entero-anastomosis drains the duodenal contents into the distal intestine When, however, it is

proximal to the stomach stoma, although the duodenal contents may drain into the proximal limb after entero-anastomosis, the stomach contents emptying through the stomach stoma must pass for some distance along the proximal limb against the normal peristaltic wave before entering the distal intestine. This seemed to him the reason why the entero-anastomosis had failed in his own case, and made it difficult for him to understand the mechanics in Doctor Stetten's case, unless the stomach contents in the latter were leaving the stomach through the pylorus and not the stoma.

DOCTOR STETTEN, in closing, insisted that the examination of the former gastro-enterostomy was not only justified, but indicated. Suppose that this had not been done and he had missed a possible gastro-jejunal ulcer, would he not have been in a very embarrassing position if the patient, a few months later, suddenly had a severe gastric or intestinal hemorrhage? When one is so close to a gastro-enterostomy in the course of an abdominal operation, and there is no active infection present, the gastro-enterostomy ought to be examined to determine its present condition. It is his custom in all abdominal operations to make a general survey of the abdominal cavity and especially at all re-operations to examine the site of a previous operation to determine the existing status, unless there are special difficulties or definite contraindications, and he is of the opinion that most surgeons feel the same way on this subject. In fact, he is rather inclined to believe that not to make such an examination might easily be regarded as surgical negligence if a lesion of importance is overlooked. Possibly if the gastro-enterostomy had not been examined, the subsequent trouble might not have developed, but even this is by no means certain. The idea of disconnecting the gastro-enterostomy when he found the pylorus patent did occur to Doctor Stetten, but owing to the fact that the woman had a subacute condition of the gall-bladder, he did not feel that a detachment of the gastro-enterostomy was justified at the time, especially as the entire loop was rather adherent, and the adhesions to the efferent limb were particularly vascular, so that the operation would have been rather difficult. As pointed out, the simple cholecystectomy itself produced quite a post-operative shock. If a disconnection of the gastro-enterostomy had been attempted, it is very questionable if the patient would have stood it.

EXTRUSION OF INGESTED FISH BONE AT UMBILICAL REGION

DR DEWITT STETTEN presented a woman, aged fifty-nine, first seen by him on April 15, 1924, with a history that for about three and a half months she had noticed a swelling to the left of her umbilicus which had not enlarged, but which had become somewhat sensitive. On examination, a round, semi-fluctuating, subcutaneous nodule about three-quarters of an inch in diameter was found at the left of the umbilicus. This nodule was adherent to the skin, which was reddened and oedematous. At the most prominent part of the nodule was a minute dark spot in the skin, suggesting the head of a comedo. The nodule looked inflammatory, but the possibility of a metastasis from an intra-abdominal neoplasm was considered, although there was no evidence of any abdominal or pelvic tumor. The nodule was excised by

ABNORMAL DESCENT OF THE TESTICLE

an elliptical incision which circumscribed the nodule. When it was freed from the fascia it was found that protruding forward from the abdominal cavity, and entering the nodule, was a fish bone which was easily withdrawn. The nodule consisted of a mass of skin and inflammatory subcutaneous tissue in the centre of which was found some thick inspissated pus. The foreign body was a thin, flat, flexible, cartilaginous structure about one and a half inches in length and undoubtedly a fish bone. The fish bone had penetrated to just beneath the cutis, the minute dark spot in the skin corresponding to the end (Fig. 4). On questioning the patient after the operation, she

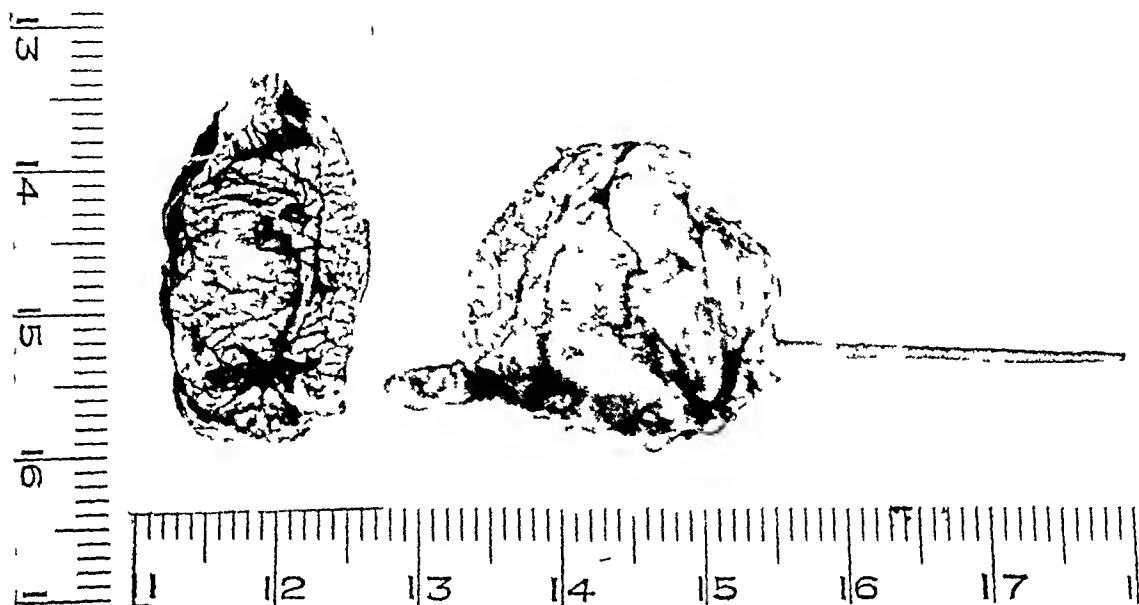


FIG. 4—Anterior and lateral photographic view of excised specimen of extrusion of ingested fish bone at umbilical region. In the anterior view (left) the dark spot in the skin where the fish bone is almost penetrating can be seen and in the lateral view (right) the fish bone is seen piercing through the inflammatory mass of subcutaneous tissue.

stated that about a year before a fish bone had become caught in the pharynx which she had some difficulty in swallowing but which finally passed into the stomach. About three months after this she had an acute abdominal attack with pain around the navel and with nausea but no vomiting. She was in bed for three days and had quite some tympanitis. At the time she was treated by local applications. After that she had no further trouble until the nodule developed some six months later. This history apparently accounted for the subsequent development of the case and the curious findings.

ABNORMAL DESCENT OF THE TESTICLE

DRS. CARL G. BURDICK and BRADLEY L. COLEY presented a paper with the above title, for which see page 867, *ANNALS OF SURGERY*, vol. lxxxiv.

DR. WILLIAM B. COLEY said that the paper presented covered the largest number of cases that has ever been published from a single hospital, and an analysis of the methods and results should be of value to the profession at large. But there does not seem to be any advantage in making the distinction of maldescended testis and ectopia, as the present writers have done. The word *ectopia*, derived from the Greek word meaning "out of place" or "mal placed," has so long been used to cover all varieties of undescended or maldescended testis that there is no good reason for giving it a different interpretation and limiting it to a certain variety of misplaced testis.

The speaker became interested in this subject many years ago, and in April, 1908, before the New York Surgical Society, read a paper on "The Treatment of the Undescended or Maldescended Testis Associated with Inguinal Hernia" (ANNALS OF SURGERY, September, 1908) reporting at that time 128 cases upon which he, personally, had operated. Unlike the series of cases reported this evening, his series included adults as well as children. Of the 128 cases then reported, eighty-four were in children under the age of fifteen years, and forty-four were in adults ranging in age from sixteen to forty-five years. In this paper he called attention to the wide variance of opinion as to the etiology of the condition, the indications for surgical treatment, and the best methods of operation. One of the great difficulties in determining the best method of operation is the fact that there are so few statistics giving the end results of the different methods employed in a large series of cases.

As stated in his paper, it is possible to divide these cases into two main groups, namely, the undescended and the maldescended testis. As regards the first group, if in its downward progress, the testis is stopped before it enters the inguinal canal, it is called abdominal ectopia, if it is stopped within the inguinal canal, it is called inguinal ectopia, if it passes outward to the external canal into the region of the upper scrotum, it is called pubic ectopia. In the second group, properly designated as maldescended testis, the testis occupies some abnormal position, *e.g.*, the perineum, Scarpa's triangle, or the aponeurosis of the external oblique, in the region of the anterior superior spine. It seems wise to retain the general term *ectopia* to include all of these varieties.

In regard to the cause of these different types of ectopia, the view expressed by Curling in 1857, that the principal and almost only agent connected with the descent of the testis was the gubernaculum, received the support of most surgeons up until comparatively recent times. Godard accepted the theory fully and believed nothing more simple than this explanation—no gubernaculum and the testis remains within the abdomen, no middle fasciculus, and inguinal ectopia occurs, while in the event of the anomalous insertion of the fasciculus either in Scarpa's triangle or the ischium, we have cruroscrotal and perineal ectopia. As late as 1887, Lockwood, after a most careful anatomical study of the undescended testis, concluded that the gubernaculum was the main factor in the descent of the testes, and he attributed the various types of maldescent to overdevelopment of portions of the gubernaculum lying in these particular regions. However, later, Sebileau, who also made an extensive research, concluded that "perineal ectopia is a purely congenital affair. It depends neither upon pathological nor anatomical causes and least of all upon the gubernaculum."

On the clinical side, Championniere, who had an unusually large experience in hernia, strongly opposed the theory of the gubernaculum origin of the undescended testis. He held that only a physiology as legendary as that which, in former times, accepted multiple testes as proven facts, could seek

to explain the descent of the testis by a legendary origin of the gubernaculum testis

The latest authoritative opinion, supported most recently by Sir John Bland-Sutton, is, that the condition is not definitely due to any of the causes mentioned but is a congenital defect, the exact nature of which very little is known

In regard to the comparative frequency of the undescended testis in children and in adults, I made a study of the statistics of the Hospital for Ruptured and Crippled covering a period from 1890 to 1908, and of 59,235 cases of inguinal hernia in the male showed that of 739 cases of undescended testis, 561 occurred in 18,410 children under the age of fourteen years, or 3 per cent, while only ninety-two cases occurred in 3848 between the ages of fourteen and twenty-one years, or 2.2 per cent, and only seventy-five cases in 37,370 over twenty-one years of age, or 0.2 per cent. In other words, the undescended testis is fifteen times more frequent under the age of fourteen years than after the age of twenty-one years

There is still a great difference of opinion on the question of whether the undescended testis is more likely to become malignant than the normally placed testicle. In a paper on "Cancer of the Testis," read before the Southern Surgical and Gynecological Association in December, 1914 (ANNALS OF SURGERY, July, 1915), Doctor Coley reported a series of sixty-four cases of malignant disease of the testis personally observed, in which, in twelve cases the disease occurred in the undescended testis. At the Hospital for Ruptured and Crippled, from 1890 to 1907, in 59,235 cases of inguinal hernia in the male sex, there were found 737 cases of undescended testis, without a single case of sarcoma of the undescended testis. Such statistics as these, however, do not give a fair estimate of the relative proportion of cases of sarcoma of the undescended testis, inasmuch as many of these cases, particularly those of abdominal ectopia, will seek relief at some general hospital rather than go to a hospital devoted specially to the treatment of hernia. The only way of determining the relative frequency of sarcoma of the undescended testis is to study a consecutive series of sarcomas of the testis. In his first twenty-five cases of sarcoma of the testis there was not a single undescended testis. On going over his entire statistics he found that in sixty-four cases of sarcoma of the testis, the disease occurred in the undescended testis in twelve cases. Odiorne and Simmons, in a review of fifty-four cases of malignant disease of the testis, observed at the Massachusetts General Hospital, found 6, or 11 per cent, in which the disease occurred in the undescended testis. An analysis of the cases observed by Chevassu, Odiorne and Simmons, and at the Presbyterian Hospital up to the end of 1914, shows the proportion as one to five. Doctor Coley's statistics show almost the same proportion, or about one to five and one-half. If, then, there are only 737 cases of undescended testis in 59,235 consecutive cases of inguinal hernia, and twelve cases of sarcoma of the undescended testis in sixty-four cases of sarcoma of the testis, one at once sees that the unde-

scended testis is more prone to sarcomatous degeneration than the normally placed testis. However, the number of cases encountered is so very small that it should not be given too much weight in the discussion of the treatment. In 1904, Doctor Coley operated upon a boy of fourteen years of age, for a left oblique inguinal hernia associated with undescended testis. Last month, or twenty-two years later, this same patient came to see him in a state of great anxiety because his physician had told him that the testis should be removed in order to avoid the risk of its becoming the seat of malignant disease. Examination at this recent date showed the testis to be small and atrophied, and placed just outside of the external ring. It would seem, therefore, that the pendulum has swung far, perhaps too far, in the opposite direction, and the view once held that the undescended testis is never the seat of malignancy has been changed so that now many physicians even exaggerate the risk to their patients.

As regards the method of operation, the method which Doctor Coley has employed is practically the same as that already described by Doctor Burdick and Dr. Bradley Coley. A very advantageous step recommended by Doctor Bevan, of Chicago, is the employment of a circular suture of chromic catgut which is passed just outside the external ring so as to include the deep and superficial fascia which, when tied, prevents any possibility of the testis retracting beyond the external ring into the canal or above the surface of the aponeurosis.

In 1908, attention was called to Keeley's operation of burying the testicle in the tissues of the upper thigh and later transplanting it into the scrotum in a second operation. We have never used this method in the Hospital for Ruptured and Crippled, believing that if one could free the cord sufficiently to enable one to place it in the thigh, it would be quite as easy and as satisfactory to place it in the scrotum at once, thus avoiding a second operation. More recently Torek has reviewed this method and modified it slightly, and a year ago Herbert Willy Meyer reported a considerable number of cases treated by this method with very good results. As far as I know, no very large number have been reported with a follow-up for a considerable period.

In the early series of cases already referred to, covering 128 operations, twenty-five represented an ectopia of the inguino-superficial type, in which the testis and sac rested upon the aponeurosis of the external oblique. There were nine cases of the inguino-perineal type, the sac and testis occupying the perineal region. In not a single case was there a recurrence, and in only two cases was the testicle sacrificed.

It is interesting to note that a somewhat larger proportion of the cases reported in his series was followed for a considerable period of time than it was found possible to do in a much larger series of cases more recently observed at the Hospital for Ruptured and Crippled. Of the 128 cases operated upon, seventy-two were traced from one to fifteen years, fifty-two children were traced from one to fifteen years, seventeen less than one year, and fifteen were not traced, of the forty-four adults, nineteen were traced

from one to ten years, four were traced less than one year, and twenty-one were not traced. Of nineteen adults examined from one to ten years after operation, the testis was found in good position in the scrotum in eight cases and at the external ring, or not stated, in the others. One case worthy of special note is that of a man, aged twenty-five years, who was operated upon five years previous, for right undescended testis of the inguinal type. The testis was brought into the scrotum and was in good position at the time of my report, five years later. Prior to the operation, this patient had been subject to epileptiform seizures occurring often within one to two weeks. After the operation these attacks ceased entirely.

In comparing the cases of adults with those of children, it was found that the testis showed a greater tendency to remain in the scrotum in adults than in children.

Broca, in 1902, reported, 138 cases of inguinal ectopia in children and sixty-two patients with seventy-nine operations beyond one year, thirty-one perfect results, thirty-five fairly good results and no recurrence of hernia.

While it is generally recognized that the undescended testis is of no functional value and that a person with a bilateral undescended testis is sterile, it is interesting to note that a patient who, at the age of thirty years, was operated upon in 1895 by Doctor Schoonmaker, of Yonkers, and in 1910 by Doctor Coley, was married in 1902 and had a child born in April, 1903. This is the second case that he had been able to find in which a patient, suffering from double undescended testicle, had become a father.

DR SEWARD ERDMAN said that recently, Mixter, of Boston, had reported the end results in 107 cases, which had been carefully followed, and found the testes in the lower scrotum in only 42 per cent, which corresponds very closely with the 40 per cent in the series of Doctors Burdick and Coley.

In both of these reports, the authors have classed as satisfactory end results about twenty to thirty per cent more, because in this number the testis was found in the upper part of the scrotum. However, Doctor Burdick, in his paper, mentions the classical forms of non-descent of the testis, viz, the abdominal, the inguinal, the pubic, and the upper scrotal types. If the position of the testis after operation is upper scrotal, it is still to be regarded as in a minor degree nondescended, and such a result cannot be regarded as entirely satisfactory. From these excellent follow-up reports, therefore, it will be seen that the Bevan operation only gave entirely satisfactory results, as regards position of the testis, in from 40 to 42 per cent.

Furthermore, by too many operators the Bevan operation is believed to include the routine division of the spermatic vessels, which must be strongly condemned as a procedure leading to atrophy of the testis in over 85 per cent of the cases, in Mixter's series. Indeed, Bevan himself once said that he only had to employ this section of the vessels in about 10 per cent of operations. Certainly, there is no logical reason to expect the already handicapped and usually undersized testis to thrive better after dividing the spermatic vessels which represent most of its blood supply.

DOCTOR ERDMAN expressed his belief that the so-called retraction of the testis, after replacement in the scrotum at operation, is more often due to contraction of the undeveloped scrotum. For even if at operation the scrotum be forcibly stretched to sufficient dimensions, there is no guarantee that the dartos will not regain its tone and again contract the scrotal sac and elevate the testis. Especially in cases of bilateral non-descent, the scrotum is so rudimentary that it is almost impossible to obtain a satisfactory result by the Bevan operation.

In all cases of rudimentary scrotum, the Torek operation is the method of choice because its chief asset is the development of a larger scrotal sac during the period over which the scrotum is attached to the thigh. The cases shown before the Section of Surgery of the Academy, last January, by Franz Torek, Carl Eggeis and Herbert Willy Meyer were ideal end results attained by the Torek operation.

DR FRANZ TOREK did not think that a testicle in the upper part of the scrotum could be considered a satisfactory result and there were only 114 cases in this series of 537 in the scrotum. As it is not stated whether they were in the middle or lower part, we may assume that some of these 114 were not in the bottom of the scrotum. Personally, he only considered a result perfect if the testicle was in its normal position at the bottom of the scrotum. He had proven that the operation of orcheopexy, the technic of which he had described in 1909 and a number of cases of which had been shown at a meeting of the Surgical Section last January, uniformly gave the result that the testicle hung in the bottom of the scrotum, and most surgeons would prefer the chance of a 100 per cent result rather than 114 out of 537. Of course it required a double operation, as Dr William Coley said, but many would probably prefer achieving a perfect result even at the expense of two operations instead of one. As regarded the division of the vessels, Doctor Torek had never considered this a proper procedure. The vessels are often very short, but if they are prepared off to a considerable height and divested of all coats, they can be brought down. One of the advantages of the operation he called orcheopexy was that by it the scrotum is lengthened and after the first few months there is no possibility that contraction of the scrotum may drive the testicle back. That is a not unimportant part of the operation.

DR EDWARD W. PETERSON said he had had the privilege of working with Doctor Torek at the Post-Graduate Hospital, and he agreed with those speakers who said it was not necessary to attach the scrotum to the thigh fascia to get sufficient lengthening. If the cord can be sufficiently lengthened, there is no trouble in keeping the testicle down in the scrotum. By systematic stretching of the scrotum before operation, one can soon develop sufficient size and length in this structure, even where it is rudimentary in the beginning.

DR JOSEPH P. HOGUET said he did not believe that in every case where there had been division of the vessels an atrophy resulted because he remem-

bered a number of cases where the testicle was absolutely normal as to size and mobility in the bottom of the scrotum after division of all the vessels. By the division of a certain number of vessels, in the majority of cases the testicle can be brought down. There were two points he wished to emphasize in regard to the technic. Doctor Burdick said the important thing was to get the testicle actually in the scrotum. It is not realized how easily it can be put in Scarpa's triangle and the scrotum should be uncovered so the testicle can be seen to be there. In regard to closing the lower cut end of the tunica vaginalis, the speaker formerly closed them all with the result that he had an occasional hydrocele. Since he stopped this practice hydrocele has not occurred.

DR ALEXIS V MOSCHCOWITZ stated that in justice to Doctor Bevan, it is only proper to say that Doctor Bevan advised the division of the spermatic vessels only in those cases in which the testicle could not be brought down into the scrotum after extensive mobilization.

Some years ago, Doctor Moschcowitz was an ardent advocate of what may be termed the extreme Bevan operation, and he published a paper on the subject, in which he described really beautiful results. Unfortunately, this paper was published after too brief a period of observation. A few years ago, Doctor Moschcowitz decided to reexamine these cases. While it is true that in an occasional case the result was excellent, in the great majority of the cases the result was exceedingly poor, in other words, the testicle had disappeared by absorption.

Since that time, Doctor Moschcowitz has never again divided the spermatic vessels and he wished to retract his previous recommendation of the extensive Bevan operation.

DOCTOR MOSCHCOWITZ has found that the important matter in operating on cases of cryptorchism is to mobilize the testes completely if necessary by liberating the spermatic vessels in the retroperitoneal space and when that has been accomplished, the testes can be supplanted into the scrotum without any difficulty.

DR BRADLEY L. COLEY emphasized the following points. The first was in regard to the importance of the fascial layers. It is not as difficult as it might seem to misplace the testicle. He had seen several such cases. One of the speakers had emphasized the importance of elongating the scrotum, making up for a deficiency in the scrotum by a plastic operation (Torek operation) on the thigh. Undescended testicle operations, in the speaker's experience, had failed because of the shortness of the cord and not because the scrotum was small. Any operation that lengthens the cord sufficiently for the testicle to lie without tension in the bottom of the scrotum may be considered successful, but any other operation that fails to accomplish this must be judged a failure. The operation that accomplishes this desideratum with the least disturbance to the structures involved may be looked upon as the operation of choice.

DOCTOR BURDICK (in closing) said in reply to Doctor Coley's criticism of

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the terms maldescent and nondescent, he had tried to make a distinction between a testicle arrested along the path of normal descent and one which had descended into an abnormal position. As far as practice is concerned, it is almost always easy to bring down into the scrotum a testicle in an abnormal position because the cord is usually of sufficient length. As far as the gubernaculum is concerned, while it seems to have a definite influence on maldescent into the thigh, on the other hand it has never been proven satisfactorily that it had any influence in the inguino-superficial type.

As regards the perineal type of undescended testicle personally the speaker had never seen a case. In cases called to his attention by others as being of the perineal type, he had proven they were not in the perineum, but in the thigh.

Doctor Burdick agreed with Doctor Coley as to the time of operation, the longer one can put off the time of operation the more chance the testicle has to descend normally.

In reply to Doctor Erdman, Doctor Burdick thought there was a good deal in what he said about the undeveloped scrotum and he also believes there is a great deal to be accomplished by Doctor Torek's operation. Nobody could refrain from admiration of the result in the cases shown last winter. Doctor Torek had claimed that his was not a traction operation. In cases where the scrotum is very much undeveloped an operation of that type is indicated. In suitable cases, where the scrotum is more normally developed the operation the speaker had described he believed to be better.

As to Doctor Moschcowitz's remarks, Doctor Burdick thought that when the testicle was in the abdominal cavity it was necessary to divide the vessels before one could get the testicle down, if that is to be done, the decision to do this must be arrived at fairly early. The speaker had seen one or two cases where the testicle had sloughed, caused probably by making too great an attempt to divide all the fascial bands and thus injuring the tiny artery which accompanied the vas.

As to the importance of the fascial planes, he had seen the testicle placed in the wrong fascial layer time and time again during a period of twelve years, and a large number of experienced operators had made this same mistake.

BRIEF COMMUNICATIONS

THE SKIN FLAP METHOD OF COLOSTOMY

LAST January I reported a method in which a skin flap cover was utilized to surround the projecting intestine.* In this connection it was pointed out that in any of the old type of colostomies the opening was on the same plane with the skin of the abdominal wall. The colostomy cup had no means of anchoring itself at the artificial anus allowing the free escape of fecal contents. The work was altogether experimental. Since the last report I have been able to do this form of colostomy on two patients. One is now convalescing and his case will be reported at a later date. In the following case, a



FIG 1 —Initial skin incision

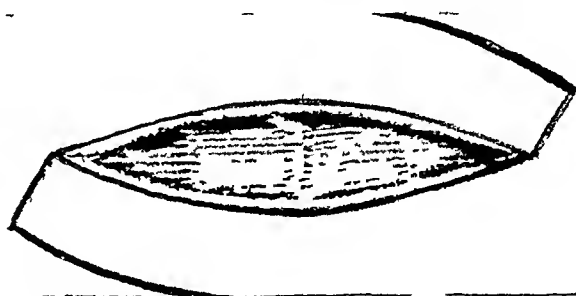


FIG 2 —Additional incisions to form skin flaps

colostomy was performed in the manner described, only the skin flaps were fastened somewhat differently.

Mr Wm B, aged fifty-nine, was admitted to the Emanuel Hospital, July 2, 1926. He came to my office complaining of cramps in the abdomen and prolonged spells of constipation. The cramps came on periodically and were relieved by cathartics, lately, even cathartics did not seem to bring any relief. During January, 1926, the patient noticed that he had a great deal of aching in the epigastrium, at approximately the same time he also observed two or three masses, each one the size of a walnut, in the left inguinal region. He consulted a physician who removed these glands and told him it was a "fibrous growth." In the last few days he noticed a large mass in the left side of the abdomen.

The physical examination revealed a well built, fairly well nourished individual. There was a lobulated mass about twelve centimetres in diameter situated in the left side of the abdomen, about the level and also below the umbilicus. The tumor itself could not be removed but the skin over the tumor was quite movable. There was no tenderness experienced on pressure. An operative scar about ten centimetres long was found in the left inguinal region.

The urine contained a trace of albumin. The hæmoglobin was 72 per cent with a normal amount of erythrocytes and leucocytes. The Wassermann test was negative.

An exploratory incision, about ten centimetres long, was made in the left rectus muscle, the point of the umbilicus dividing the incision into two equal parts. On the left side of the spinal column, about the level of the twelfth dorsal vertebra and spreading down into the pelvis, there was a lobulated bleeding mass occupying the retroperitoneal space and pressing upon the pelvic colon. The tumor mass was fixed. No evidences of metastatic spreading was found. The sigmoid colon was brought to the outside, the peritoneal covering of the external surface of the sigmoid mesentery was incised in

* Steinberg, Moses E. A Skin Flap Cover for Projecting Intestine. *ANNALS OF SURGERY*, January, 1926, vol LXXXIII, p 126.

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order to freely mobilize the gut. The bowel was divided in an aseptic manner. The distal loop was inverted by a purse-string suture and dropped into the abdomen. About seven centimetres of the proximal loop of the sigmoid was brought out above the level of the skin and surrounded by skin flaps as depicted in the accompanying illustrations (Figs 1 to 5). It is to be noted that the skin flaps are fashioned in a different manner than

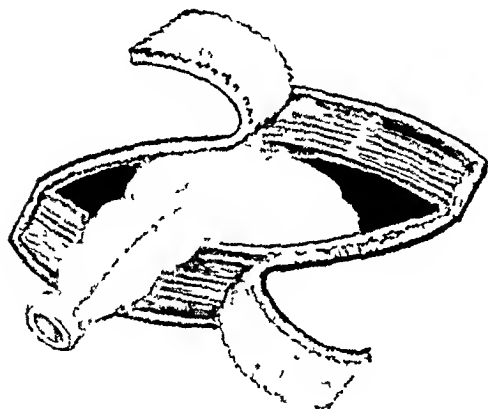


FIG 3 —Skin flaps dissected and bowel delivered

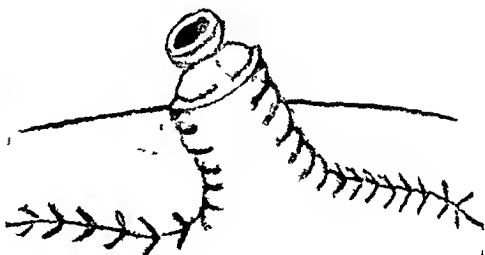


FIG 4 —Projecting bowels covered by skin flaps

suggested previously. It was not necessary to incise or undermine the skin in order to facilitate the approximation of its edges after the flaps were made. The bowel was opened by means of a cautery on the third day and the mucosa was sutured to the skin.

The post-operative recovery was rather stormy, the patient developed a paralytic type of ileus which was relieved by enemas injected through the colostomy opening.



FIG 5 —Appearance of skin flap colostomy four months after operation

It has been nearly four months since the colostomy was performed. All the structures concerned in the performing of this colostomy, the skin flaps, and mucosa of the bowel, have a healthy appearance. The patient carries a colostomy cup which is cleaned only one or twice a day. The feces escape directly into the cup and there is no soiling of the skin about the artificial anus.

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NONUNION OF THE HIP

In a communication in the *ANNALS OF SURGERY*, October, 1926, Dr. Royal Whitman commented on my paper "Ununited Fractures of the Hip." In effect, he asserted that my description, by illustration, of the Brackett operation was inaccurate. I grant that if one adheres strictly to the technic as described by Brackett in 1917, this illustration is inaccurate, but the operation depicted is in basic principle similar to Brackett's.

NONUNION OF THE HIP

Inasmuch as Brackett's operation had as its object the revascularization of the head and consequent union with the reconstructed upper end of the femur, we have fallen into the habit in the Mayo Clinic of calling any attempt of this kind a Brackett type of operation. Although we have used a somewhat different technic from Doctor Brackett, because we felt that the nourishment to the head must come from the spongy bone of the trochanteric region rather than from any blood supply brought in through the muscles and portion of the trochanter that he reimplanted, I felt that for descriptive purposes, Brackett's name should be used.

My conception of the essential feature of the underlying principle of the Brackett type of operation is exposure of the fracture area, freshening of the head and remodelling of the upper end of the femur to bring spongy bone, rich in bone-forming properties, in contact with the head and thus to secure union and skeletal support. My conception of the essential feature of the Whitman type of operation is excision of the head and insertion of the remodelled upper end of the femur into the acetabulum for skeletal support. Both operations shorten the portion of the femur between the proximal end of the distal fragment and the trochanteric area.

The raising of the trochanter in whole or in part with the attached muscles has been practiced for many years to expose the hip-joint. Doctor Whitman has forcibly called to our attention the value of fastening it at a lower level on the shaft of the femur, but, when he states that this step is the essential feature of his reconstruction operation, it appears to me that, important though this step may be, it is overestimated. His object in this operation is to get skeletal support. It is obtained by placing the remodelled upper end of the femur in the socket and not by transferring the trochanter to a lower level on the shaft.

I agree with Doctor Whitman that, if there is extensive absorption of the neck of the femur, his operation is the method of choice, except in the case of young persons for whom I believe the Brackett operation, or a modification of it, will give better results. There is at present a tendency to disparage the bone-grafting operation popularized largely by Albee many years ago. Because this operation has failed in unsuitable cases does not mean that it should fall into disuse. Undoubtedly the operations mentioned all have their place, and while Doctor Whitman is to be congratulated on the development of a very successful operation for cases suited to it, I am quite sure he will agree that it should be confined to those cases in which there is no reasonable chance of effecting anatomic restitution by means of the bone-graft. With his statement that the bone-pegging operation offers but slight advantage over the results obtained by the Whitman reconstruction operation, I cannot agree basing my opinion on the results obtained in our operative cases, a good proportion of our bone-pegging operations have resulted in practically normal hips.

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NECK PAIN IN SUBPHRENIC ABSCESS

The importance of neck pain in the diagnosis of subphrenic abscess has been given but scant attention by surgeons and others. Of recent writers on this subject, Dexter¹ seems to be the only one who definitely mentions it. A diagnostic sign of such great value should be given greater prominence.

In 1922, Capps and Coleman² carried out a series of ingenious experiments to determine the localization of pain from stimulation of the parietal and diaphragmatic peritoneum. A trocar was passed through the abdominal wall and through this, in turn, was passed a long silver wire to various parts of the parietal and diaphragmatic peritoneum. Patients having ascites or individuals who had had an injection into the peritoneum were studied. The investigators found that the peritoneum covering the diaphragm is devoid of light pressure sense, but that on strong pressure with a headed point or light contact with a rough point there is an acute response of pain sense. The localization of pain from stimulation of the diaphragmatic peritoneum is never in the diaphragm itself. It is always referred to some distant part. Stimulation of the outer margin causes diffuse pain over the lower costal region and subcostal abdominal wall. Stimulation of the central portion produces *pain over a sharply limited point somewhere along the trapezius ridge*. These impulses are doubtless carried by afferent fibres of the phrenic nerve to the cervical cord and thence referred to the neck by the sensitized cutaneous nerves of the fourth cervical segment.

In the following case neck pain was a very characteristic feature. It was present with intermittent severity for perhaps a week before the drainage of the subphrenic abscess.

J. M., a boy of eight years, came home from school, October 22, 1926, with a pain in his abdomen and vomiting. An osteopath was called and he attended the child for three days until October 25, when obviously being worse, a pediatrician, Dr. C. A. Aldrich was called, who in turn immediately summoned the writer. At this time the boy appeared to be acutely ill. The abdomen was uniformly distended, somewhat rigid, and tender. There was increased tenderness in the right lower quadrant. The temperature was 102 degrees, the pulse 120-130, and the respiration 36. The leucocyte count was 16,800. The patient was taken to the Evanston Hospital and a laparotomy performed. On opening the peritoneum a large amount of free, watery pus gushed forth. A gangrenous appendix, evidently the cause of the generalized peritonitis, was removed by "ligation and drop" method. Three rubber tubes were used for drainage. The patient was immediately placed in Fowler's position and fluids were pushed.

For the first week the convalescence was fairly satisfactory, although the temperature never was less than 100 and the pulse less than 110. Beginning the seventh day the evening temperatures began to be higher each day until the twelfth day it reached 103.6°, and the pulse averaged 120-130. On this day the patient was anesthetized and the wound explored by finger and a rectal examination made. No evidence of abscess was found, however. During these days a very striking thing was the patient's more or less constant complaint of *pain in the neck*. This pain was in the right side of the neck above the clavicle. Its significance was not recognized until later. On the thirteenth day Doctor Aldrich noted an area of dullness of the right lower chest. The patient was seen by the late Dr. Albert E. Halstead on this day, who was of the opinion that there was a subdiaphragmatic abscess. The leucocyte count was 25,000. X-ray examination

AUSCULTATION IN DIAGNOSIS OF FRACTURE

was reported by Dr E L Jenkinson as follows "The right diaphragm is greatly elevated, extending upward to the third rib anteriorly The heart is displaced to the left The left diaphragm is normal The elevation of the right diaphragm is probably due to a subdiaphragmatic abscess with compression of the right lung" (See Fig 1) On the fifteenth day (November 9, 1926), under ethylene anæsthesia, an operation for subphrenic abscess was done A four-inch incision was made over the right tenth rib in the posterior axillary line About $3\frac{1}{2}$ inches of the rib was resected subperiosteally Incision was then made through the visceral pleura into the pleural cavity itself There was no evidence of infection in the pleural cavity and the lung was retracted above this incision The visceral pleura was now sutured to the parietal pleura which covered the dome of the diaphragm in an elliptical manner, leaving a space some $1\frac{1}{2} \times \frac{1}{2}$ inches through which to incise the diaphragm (See Fig 2) The latter was then incised and 800 c.c. of foul-smelling pus poured out Cultures of this fluid showed various organisms including Gram-negative bacilli, Gram-positive cocci in pairs and chains, and Gram-positive bacilli The abscess cavity was cautiously explored with the finger, but no accessory pockets were located The skin was sutured to the periosteum, in order to have less painful granulation area at dressings, and a rubber drainage tube was sutured in place The temperature quickly subsided, but three days later an abscess over the right inguinal ring became evident Under nitrous oxide gas this abscess was incised and 1-2 ounces of thick, creamy pus evacuated From this time on the convalescence was uneventful The discharge from the subphrenic abscess diminished in quantity daily Thirty days after admission the patient was discharged from the hospital to his home in care of a nurse He rapidly gained in weight and three weeks later the wounds were completely healed and the child was in excellent health

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BIBLIOGRAPHY

- ¹ Dexter, R Amer Jour Med Science, vol clxx, p 810, December, 1925
² Capps, J A, and Coleman, G H Arch of Int Med, vol xxx, p 778, December, 1922

AUSCULTATION IN DIAGNOSIS OF FRACTURE

Auscultation, so widely used in general medicine and surgery, is strikingly neglected in the differential diagnosis of fracture It is true that the tests that may be applied in suspected cases are numerous and varied It is true that many accident cases are so obviously fracture cases that a mere glance or short palpation is all that is required to establish the diagnosis Yet the cases in which fracture is suspected but indeterminable without X-ray are not rare This is especially true of those cases in which the fracture is transverse and without displacement

It is well known that bone is an excellent conductor of sound If one places the ear or stethoscope over one point on a bone and percusses over another, the transmitted sound is sharp, clear, and distinct This same phenomenon occurs when the points of auscultation and percussion are covered by skin and fascia that is, are subcutaneous* It is also readily understood that any interruption in the continuity of the bone between the points of auscultation and percussion will cause an impairment in sound transmission This may be verified by comparing the sound, similarly elicited, from the symmetrically located bone of the body if desired Advantage may therefore be taken of these facts in cases of suspected fracture by listening—

say over a condyle of the humerus while percussing the greater tubercle. Integrity or rupture of the continuity of the shaft of the humerus will then be indicated according as the sound is sharp and clear or muffled or absent.

These ideas prompted the author to attempt a study of fracture cases, using the principles and methods noted above. Results were gratifying from the start. One case, for example, was that of a woman with suspected fracture of the femur. The lady believed that she had heard something crack on falling. Diagnosis was indefinite. Auscultation, used as above, showed definite impairment of sound transmission. The note was dull—not sharp. X-ray showed a transverse fracture without displacement.†

Another case was that of a boy who had injured his leg. The nature of the accident made fracture of the fibula very possible. Point tenderness was elicited over the junction of the middle and distal thirds of this bone. No other striking signs nor symptoms of fracture were present. Diagnosis was uncertain. The auscultatory test was negative. The sounds of both tibiae were equal and of the same character and quality. X-ray failed to show presence of fracture.

In a third case there had been fracture of the tibia with various treatments and mistreatments. There was healing extending over several months with marked bowing of the extremity. Impairment of sound transmission (elicited with particular ease from this bone due to its subcutaneous location) was present. There was also present a strikingly musical quality to the sound which was very different from that obtained in similar manner from the tibia of the other limb.

It is believed that these experiences‡ are sufficient to indicate the possibilities and usefulness of this method. X-ray is costly, requires time and trouble, and is frequently unavailable altogether. Any test then, which is simple, ready, economical, definite, and characteristic, and which may frequently serve in the place of the X-ray, should be welcome to the profession. It is hoped and believed that the procedure described herein will furnish such an additional diagnostic aid.

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* Clear transmission of sound across the joints of the phalanges was obtained while percussing the end of the distal phalanx.

† The test was very definite. Only a very fine fracture line was shown by the plate.

‡ Each of these cases was verified by experienced physicians.

CHANGE OF EDITORIAL ADDRESS

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THE INFLUENCE OF TRADITION IN SURGERY*

BY HUBERT A. ROYSTER, M D

OF RALEIGH, N C

IN ONE of his delightful essays Sir Clifford Allbutt voices his belief that "medicine was saved by the honor and vitality of its surgery from the fictions and the petrifications of philosophical systems," and "that surgery, though scorned by the high stomachs of the Middle Ages, has never been the child or the humble companion of medicine, but the stone of the corner and the key to its true method" When a great internist thus extols our art, there is placed upon us who devote ourselves to its service the burden of deserving such praise and the responsibility of proving our respectable descent Moreover, when our confrere further testifies that to certain professional ancestors "our debt is rather one of preservation of good tradition than of discovery," interest awakens in those first things deposited in the cornerstone to be unlocked only by the true key

Tradition, I confess, has ever intrigued me, has always caught my imagination There is somewhat of savory satisfaction in the thought of doctrines, methods and customs literally handed down from antecedents to posterity, from one generation to another, from forefathers to descendants by word of mouth without written memorials And this is tradition It constitutes the core of truth in some great ecclesiastic sects, it forms the nuclear basis of permanent fraternal orders, it saves for the world what is worshipful in pottery, in painting, in all the work of artists and artisans—this giving over from father to son, nay, to all those in a family, a way of reproducing the Good, the True, the Beautiful

"Nobody can make a tradition," protests a character of Hawthorne's, "it takes a century to make it" But its transmission adown the generations of men is near to creative expression in that it preserves, and mayhap meliorates, the process That which is handed down may be an intangible, unponderable thing—a statement, an opinion, a body of knowledge, or merely a trick of the hands, a mixture of dyes, a mechanical form Yet it is real and composes the finer art, no doubt, for that it is not reduced to printed words

Yet written tradition remains A practice brought down over a long number of years is finally put into writing and carried on forever afterward as an accepted method This is none the less a traditional precept in its conception and its character After all, as Lowell puts it, "there is only one

* President's address before the Southern Surgical Association, December 15, 1926

thing better than tradition, and that is the original and eternal life out of which all tradition takes its rise"

In a sense the line between tradition and myth is often difficult to distinguish. One may merge into the other. The differentiating mark is to determine whether the doctrines stand the test of time, whether they remain through the ages as lasting verities, or whether they have faded and been cast aside in the light of progressive knowledge. When ancient practices fail to correspond to modern experience you may be sure they are spurious. But, if they sustain and strengthen as years accumulate, their real merit is attested. As Haldane warns, however, that "we must learn not to take traditional morals too seriously," so perhaps it behooves us not to lay too indiscriminate a hold upon all that is passed down to us, but cleave only unto the "preservation of good tradition," that which abides, which becomes part and parcel of our practice.

Are there not valid traditions in surgery? Are we not beholden to an extensive mass of oral information, inexact records, if you will,—evidence of things far in the past, imparted from the earliest times to the present? Are we not dependent upon a continuing compact of truth, thought out and tried out, borne to us through centuries from seer to student in personal contact over and above what has been written? How else account for the perseverance of our surgical saints in the Dark Ages? Truly the preservation of tradition in surgery has contributed to its succession no less than the published treatise or the written word. Tested method handed down from master to pupil is quite as valuable as, and doubtless more impressive than, the studied statement recorded on the printed page. No derogation here shall lie upon the records of our art, without them we should not have advanced, we would have been deprived of the greater knowledge of the past, and we could not now carry the gospel of surgery to all peoples. Take away surgical tradition, however, and you wipe out the personal impression, the inspired example, the visualized achievement.

From the beginning tradition has established itself in surgery. Certain primæval principles which have endured are now our common property, a fixed part of our knowledge and our performance, put into play without a thought of their derivation. So glibly do we practice the precepts of our fathers that we forget, if we ever knew, the basic source, from which come the tenets of our faith. Though "tradition wears a snowy beard," not all its elder doctrines are decadent nor all its newer postulates perfect.

"But what are true, alas! they are not new,
And what are new, they are, alas! not true"

What is old may appear very new, and what seems new may be very old. Really, "nothing is so new as what has been long forgotten." Not soon shall I forget the great Halsted, scheduled to present before a session of the Southern Surgical Association his original work on banding an aneurism, but instead throwing open upon the desk a book, found in a library the night before, containing a complete description including colored plates, of an

identical method published by a French physician in the eighteenth century. The tribute of an open-minded investigator to the esteem of "whatsoever things are true"

Surgical traditions, then, whether ancient or modern, have lived to influence later times, only if they were genuine and successful. Adoration of a fetish or the exaltation of spurious doctrines, originating in charlatanical minds, can lay no claim for regard. Our faithful fellows of the olden times saw to it that these false practices were discarded, that ineffective methods were improved. Paré, the renowned pragmatist, "opened a new era for surgery," according to Packard, "by revealing to the surgical world the value of personal experience combined with a knowledge of the science of surgery, as contrasted with the slavish submission to traditional dogma which had heretofore prevailed." Is it not something to overturn older traditions, unearth the good in others, or substitute fresher and sounder ones? This is the way the spirit of real tradition works. The traditions of surgery have come down to us in long procession and they are still in the making. To-day's unwritten method may be the tradition of to-morrow. Recall our comments upon the "new" and the "true." Says Paré to his critic, the "little master": "'To tie the vessel after amputation is a new remedy,' say you, 'therefore it should not be used.' This is badly argued for a doctor."

As well as I have been permitted to separate them, the surgical traditions coming from the remotest times, constituting a part of our present heritage, occur to me in three aspects: the intellectual, the moral and the technical. These divisions, indeed, contain the three essential ingredients for the making of a good surgeon in any age—a clear head, an honest heart and a skilful hand.

Those principles handed down chiefly through the intellect would comprise knowledge gained by study of cases and watching the effects of certain practices, information derived from discussions at the time of, or after, the examination of patients. Mere trying out, however, cannot compensate for intelligent instruction, for "experience is fallacious." But,

"He who doth strive against experience,
Is not worthy to discourse of high science"

The moral traditions of surgery have had to do largely with cultivation of sound judgment, appreciation of the human element and recognition of the personal equation. These qualities are innate rather than acquired but are capable of remarkable development in the right kind of an individual. Standards of ethics and codes of conduct are designed to uphold compliance with the highest conceptions. But how fruitless are written rules of deportment! Those who need them are hardly to be bound by them, and those who would feel bound by them do not need them. More than all in the matter of the moral perception of the surgeon is his association with "those of like faith and order," an imbibing of the inner essence from leaders and teachers who are worthy of admiration, of imitation. In no wise better than by tradition can judgment, personality and humanity in surgery be exemplified. Right constantly one is able to estimate a colleague's surgical class by knowing

his instructors, his senior officers, his associates, particularly those whom he strives to copy. The earmarks of tradition stand out strong—the unconscious working of precept and example, more potent and protracted in its sway than mere written words.

Technical tradition is no whit less important or less ethical than that attained through the intellect and the spirit. In truth the mechanical side of surgery, nothing more than the coordination of head and hand, combines the attributes of both the previous principles. Emphatically character shows in the surgeon's handiwork. Conscientious technic is the sign of a high moral purpose expressed in its most practical form. Tradition here plays a powerful part. What is described and printed often is not near so striking as what is demonstrated and passed on. Both means are essential. Description and illustration form the best alliance, knowing how and showing how produce the most effectual arrangement. "The operations of surgery," said Pare, "are learnt by the eye and by the touch." So much the more valuable then, is the education of the surgeon which comes through observation and experience, bolstered up by previous drilling in fundamental knowledge, and guided by the personal hand of a preceptor, rather than through a helpless dependence upon theoretical instruction without a thorough training in actual contact with a competent and commanding master. Further from me than anyone else I know is any intention to flout the close study of surgical literature or the immense benefit resulting from mental and cultural preparation for the surgeon's career. Learning everything possible from these sources as well as acquiring all that comes through the great body of tradition brings us to the ideal every loyal surgeon strives to reach. We find difficulty in appreciating the unwritten unless we know the written, we cannot reap the largest advantage of the practical unless we are acquainted with the theoretical.

Examples are not wanting in surgical annals to show the weight of tradition. The great pioneers passed on to us through their apprentices and successors most precious truths and wholesome practices. Their followers added to, or subtracted from, these methods, as the need might be. Even down to this period the force, often insensible force, of traditional experience is recognized. Not all the ancient lore of our surgical sages has come down to us either in documentary or in unwritten memorials, much of each is unworthy of transmission. What has been written is available for all, that which was handed from person to person has had an unconscious influence upon every one of us. And behind what was preserved in writing stand the greater unsaid, yet loud speaking things—character, prestige, truth.

The professional "Father" of us all sets the pace in his famous works, long since made available for perpetual record. Beyond and above all that he wrote, between the lines of his every page, may be seen the stamp of tradition, furnishing the motif, enveloping the scene. Hear the immortal Hippocrates as he describes the setting of an operation. "The things relating to surgery are—the patient, the operator, the assistants, the instruments, the light, where and how, how many things, and how, where the body, and the instru-

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ments, the time, the manner, the place" Further "the operator is either sitting or standing, conveniently for himself, for the person operated upon, for the light" Again "The robe, in a neat and orderly manner, is to be thrown over the elbows and shoulders equally and proportionally" Specifically, he advised that "the nails should be neither longer nor shorter than the points of the fingers, and the surgeon should practice with the extremities of the fingers, the index-finger being usually turned to the thumb, when using the entire hand, it should be prone, when both hands, they should be opposed to one another

One should practice all sorts of work with either of them, and with both together (for they are both alike), endeavoring to do them well, elegantly, quickly, without trouble, neatly and promptly" Speaking of instruments, he counsels that they are to be handled "so that they may not impede the work, and that there may be no difficulty in taking hold of them But if another gives them, he must be ready a little beforehand, and do as you direct"

What a lesson in detail is this orderly recital of surgical technic, surely not to be despised in this modern day! Can we not perceive in the background of the picture the glowing personality of the master, the enthusiasm and energy, the inner fire and the holy zeal, inexpressible in words? He treats of the preparation for the operation, putting the patient first and the place last He considers the position of the surgeon and his relation to the light He lays stress upon the operating gown and its proper adjustment He devotes care to the finger-nails and the use of the hands, apparently advising the surgeon to become ambidextrous—a suggestion which the elder Ashhurst, however, deprecated as likely to bestow upon the operator two left hands Lastly, he notes what is perhaps the greatest gift in an assistant—anticipation

The reason that Galen dominated medical and surgical thinking for over fifteen hundred years, was his reliance upon practical evidence and his talent in demonstrating its application Arabian physicians were largely instrumental in upholding and carrying on Galen's teachings It has been said of Vesalius that "he cast aside tradition and saw with his own eyes" But did he lose the spirit of ancient learning or despise the truth as handed down from his forbears? Undoubtedly not, for from the same source as this criticism comes the admission that Vesalius not only did not overthrow Galen, but was his follower in science—improved on him, corrected many of his errors, but nevertheless stuck to the doctrines of his teacher Although the supreme contribution of Haller was his voluminous work on the history and literature of surgery, yet his important accomplishment, in Mumford's view, was "his teaching surgeons how to study," and "by his example he did more even than by his preaching"

If there ever was one among us who both absorbed and generated tradition, it was John Hunter In his early life, untutored in letters and uninformed of what had been done before him, he became later associated with educated companions and lived in an environment from which he

derived profound knowledge. Always, however, "he did his own thinking" and he was conspicuously able to pass that thinking on to others in most vivid fashion. He had a passionate disdain for published dissertations and held to methods of demonstration and experimentation. His young pupils were inspired and lifted up by close communion with this embodiment of genius.

The imperishable Joseph Lister, without whose life and labors we would not, here assembled, discuss surgical problems of the cranial cavity, the abdomen, the joints, the thorax, nor revel in the unblemished healing of our wounds, was preeminently a child of tradition in surgery. By inheritance and education his training was that obtained in the usual line of association with the highest type of surgeons in his day. He received the best instruction and embraced the widest opportunities of his time. But he went his colleagues one better: he observed and pondered over and was awakened by what they had taken as a matter of course. He was fired by a glow of discontent. He put together what had been handed down to him, conquered the most terrible enemy in the domain of surgery, and forthwith made a new tradition. His disciples dispensed his doctrine and his procedure, not to change his principles, only to perfect his methods. And what one of us has not gained more from transmitted Listerian tradition, from knowledge acquired at the hands of those who were with "The Chief," than from information secured in the perusal of his written theses? In truth I might venture the assertion that scarcely one of us has read the published papers of Lister from his earliest studies up to his final address. And yet from those pioneer pupils who went from the uttermost parts of the earth to worship at his sanctuary, the whole surgical world soon heard the tidings of antiseptis.

What shall be said of surgical tradition in this newer age? It still exists, nay, let us hope, even the older spirit has not departed. Who among us does not feel the satisfying reflection of a former fellowship with a teacher, a preceptor, a "chief," source of the light that has never failed? Do we not count our apprenticeship with such men the crowning glory of our experience? Far more penetrating and memorable are the concrete sayings and doings of these men than any collections of their writings or transcripts of their lectures. Understand me: study of surgical authors is essential to a broad conception of our science, it should be encouraged, required, insisted on. But the highest development of the art of surgery can come only through traditional association. Think of Gross, Tieves, Kocher, merely in terms of their texts and they stand out, of course, above their fellows, but consider them intimately in the radiance of what they brought out in their assistants and students and they shine on as stars that cannot be dimmed.

With what measure shall we appraise the value of the teaching transmitted by a Richardson, a Murphy, or an Ochsner to those so fortunate as to come within their circle? And who would exchange this inner acquisition for the knowledge gained from their printed words, clear and cogent though they be? We of the younger time may well pause and contemplate our privilege in the possession of sound surgical tradition as exhibited in our own contemporar-

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ies the eminent and masterly Mayo, the skilful and daring Deaver, the scholarly, scientific Matas, the sane, resourceful Finney. Consecrated allegiance to the innermost spirit of these our leaders, providential contact with them in their professional life, will bring us to a realization of what faithful tradition they in turn have brought down the path of the ages. There is something to be won from this companionship that comes in no other way. And what it is we may not know. It may be the touch, the presence, the attitude, the word by the way. But there it is, if we find it.

It means much to have been with the masters. Not all of us, unfortunately, can trail with the great, or find opportunities for training under the celebrated of the earth. But we can cling to "good tradition" wheresoever we recognize it. Beside the masters of repute there are also masters in spirit, for some most unsung are most inspired. They, too, link the fundamentals of one period with those of another. I agree with those who believe that the highest attainment of a teacher is to raise up pupils greater than himself. Thus the ambition of a surgeon should be to develop at least one competent successor. This may be an almost impossible objective with a few, it should be the goal of all, so that there may be fulfilled the prophecy, "and greater works than these shall he do." It can be brought to pass only through the vital bond of tradition, literally the handing over of knowledge from master to apprentice. Through this channel alone can be carried forward the expanding ideas of our progressive science, each succeeding generation bettering its predecessor, each fellow of the craft bringing up an understudy who may bear the standard still higher.

Newer and wider knowledge will surely arrive, simpler and better methods must be found, but certain principles are eternal. There are surgeons who are tempted into the belief that change necessarily means improvement, there are some who stubbornly decline to consider any variation from fixed usage, there are still others who, while refusing to be governed "by doctrines fashioned to the varying hour," yet willingly and eagerly take hold of the new, if it be true, who discontinue their customary methods and discard their pet practices whenever a better way is opened. This is the truer part. In such an attitude one keeps unsullied the traditions of the past and by the same sign looks for added wisdom throughout the succeeding years.

The young aspirant of the present period has not only extensive opportunities for educating himself under the individual teacher, but also abundant openings for surgical pilgrimages to the shrines of other worthies. Good is gained by going from the place of original training to another, even if less famous, for all wisdom did not originate, nor will it end, in any particular location. It is well to learn in the beginning that there are "more things in heaven and earth, Horatio, than are dreamt of in thy philosophy," that there are more ways than one of doing the same thing. Some of the most eminent American surgeons now at the less active stage of their careers owe much to early rounds of the operating rooms of the older men who were animated

by the traditions of our forefathers Peripatetic visiting, engaged in loosely and without purpose, is of no avail Systematic attendance upon clinics, seeking for light upon some obscure subject, hoping for help where it may be found—these represent legitimate and durable efforts of the honest surgeon It has always been the custom among those who lead In his account of the ideal surgeon the mighty Guy de Chauliac provides “that he should have seen others operate”

The Southern Surgical Association in itself is a tradition This unique organization, over which by your generous indulgence I have now the honor to preside, was conceived in an unselfish devotion to the faith of the fathers and born in a righteous regard for the highest aims of surgical science Now nearing its fortieth year of existence, the Association remains true to its original ideals, not for one moment has it departed from the spirit of the principles laid down by its Founders

What are the factors which have kept us true to our origin, that have knit us closely together and still set us apart from all other similar societies? I love to believe that it is because we are a guild whose brothers are bound in a common purpose to relieve suffering, to put away death, to grow in scientific grace, to add to the world's weal We have stood for these things, and we will stand for them to the end I am persuaded, also, that exploitation has never entered our threshold, and that no low or unselfish interest whatever has guided our thought Can more be said? Yes, this Paramount and pre-eminent in the very warp and woof of this Association is an inherited tradition, gathered in the souls of the Founders, gaining momentum through the decades and going on to its flower in the lives of us all That tradition is not visible on the printed pages of the constitution and the by-laws, neither can it be discovered in rules, resolutions or reports It exists in the minds and hearts of the Fellows, comrades in reverence for the right That tradition is the tie that binds us It is honorable, it is sacred, it is immortal Hold fast to that which is good

TREATMENT OF INFECTIONS OF THE FACE^{*}

By JOHN W. PRICE, JR., M.D.

OF LOUISVILLE, KY

THE treatment of infections of the nose, upper lip and face, differs from the treatment of other infected areas, on account of the anatomy of these parts. Here there is increased danger of thrombophlebitis, embolism, cavernous sinus-thrombosis, meningitis, septicæmia and pyæmia.

From these infections bacteria readily enter the facial veins which have no valves, from the facial vein the bacteria may pass into the ophthalmic vein and so to the cavernous sinus, Treves¹, or, via the pterygoid venous plexus to the cavernous sinus, Taylor², or, the bacteria may pass from the facial vein to the external jugular.

In a very excellent paper on this subject Martin³ shows that the serious nature of these lesions was recognized seventy-four years ago. Later autopsies on patients dying with facial infections, showed thrombophlebitis of the facial and jugular veins, thrombosis of the cavernous sinus, septicæmia, pyæmia and lung abscess.

Sir William Wheeler has reviewed this subject recently in an editorial in the October number of *Surgery, Gynecology and Obstetrics*, and mentions four fatal cases.

In the past ten years there have been published at least eight articles on the subject. Kahn⁴ reports three fatal cases of lip infections, which were in a hopeless condition at the time he first saw them.

Martin³ reports seven cases who had widespread general infection, or cavernous sinus-thrombosis complicating infections of the face, when they came under observation. The striking thing in the histories of Martin's cases is that all of these patients had picked or squeezed a pimple, or had had one opened by the family physician. These seven patients were admitted to St. Luke's Hospital, New York, during the period between July 17, 1911 and January 8, 1922. All were operated upon at once by multiple incisions under anaesthesia, and six died.

The late Dr. J. William White was ever fond of saying "My friend, Sir Frederick Treves, says so and so," and years later I remembered his saying that Sir Frederick Treves said, "Infections of the lips should not be cut in the early stages on account of the danger of facial vein infection and thrombosis." This advice of Treves has been overlooked in the past by many physicians.

In the summer of 1917, a friend had a pimple in the nose. On Saturday morning he went to see a well-known specialist who opened the pimple. On the following Tuesday morning he died.

^{*} Read before the Southern Surgical Association, December 16, 1926.

At this time, the late Dr W O Roberts remarked to me that he had never known a patient who had a pimple on the nose, lips or upper part of the face to recover, if the pimple were cut

The following case, however, illustrates that such a patient may recover

In the Fall of 1917, while in charge of a surgical service in the Base Hospital at Camp Taylor, I was asked to see in consultation, a captain who had had a pimple in his nose incised by a Nose and Throat Specialist

The infection began in a hair follicle inside of the left nostril. The nose became greatly swollen and œdematous. The specialist opened the pustule on the inside. Thirty-six hours later, when he came under my observation, the nose and entire side of the face and eyelids were swollen and œdematous, the nose was hard, infiltrated, and covered by glazed, purplish-red, skin. In the centre of the left side, at the level of the nasal bone, there was a small necrotic point filled with a gray slough, and two or three other places which were pointing. Temperature was 101. This patient was treated by the method to be described later, and recovered. I might mention that when suppuration ceased the skin defect on the side of the nose was one inch by one-half inch. At the end of three weeks he had a lineal scar. Fortunately, these severe infections are rare.

The next case to impress me, was a young married woman who opened a pustule, or pimple, on the upper part of her face. Great swelling and œdema soon occurred, she called in consultation a local physician of her home town. He made an incision in the face and in eight days from the appearance of the pustule she was dead.

CASE III was a boy, B O, six year old, who had a carbuncle of the cheek. He recovered in ten days.

CASE IV was a man, P B, a lawyer, fifty-two years old, who injured himself on the cheek while shaving on a train. A carbuncle developed and he recovered in ten days.

CASE V was the same patient, who two months later injured his upper lip while shaving on a train. A carbuncle developed and he recovered in two weeks. In this case the skin of the lips surrounding the infected area, had been protected from the wet dressings by a coating of zinc oxide ointment. When the lesion had entirely healed the zinc oxide ointment was removed with gasoline, and the lip further cleaned with alcohol. During the cleaning process the patient complained of the alcohol burning him. Fifteen hours later he had a number of pustules about hair follicles of the upper lip. Within twenty-four hours there was a pustule about practically every hair follicle of his upper lip. The swelling and œdema of the lip was tremendous. By actual measurement it was four and one-half inches long and one and one-half inches wide, so that it overhung the lower lip.

Within the next twenty-four hours the œdema had invaded the entire face, and submaxillary regions. The tenderness and brawniness, however, was confined to the lip. During this stage the entire lip had been painted with 2 per cent solution of mercuriochrome, and 4 per cent saline compresses were kept on the lip constantly. The heads were lifted off of the pustules to facilitate drainage. I seriously questioned the advisability of continuing the conservative measures. The question arose, were the conservative measures really conservative? Was not the risk of a septicæmia greater than it would be if free incisions were made into the lip? Fearing that my judgment might be prejudiced I called in consultation, Dr Irvin Abell, who agreed that we could at least postpone the dangerous incisions, as the man was holding his own at the present time.

After three days we had localization of the infection in three points, at each point the number of openings varied from four to six. At these points true carbuncles developed. As the process of liquefaction developed the connecting skin between two openings was divided. By this method from day to day, connecting two nearby openings, always towards the centre and always staying within the zone of infiltration, drainage was improved, the sloughs were discharged, and at the end of ten days almost all of the œdema of the face and neck had disappeared. Only the lip was swollen. At this point

the nurse allowed the dressings to get dry and within ten hours the lip was again swollen to twice its normal size. From then on, however, no accidents occurred and the patient made a complete recovery.

CASE VI—October, 1926, Mrs. J. P. E., had a pustule on the lower lip. The infection spread and at the time I was called in consultation there was drainage from five openings. Four openings on the outside and one opening on the inside. There was tremendous œdema of the face and neck. The same treatment was used as is described below. The patient recovered in seventeen days. The external scar is lineal.

Treatment—The treatment of infections of the nose, upper lip and upper part of the face may be outlined according to the degree of the infection.

The infected process may be seen in three stages. First, the initial lesion, second, the period of extension, and third, the period of thrombophlebitis, embolism and septicæmia.

The First Stage—The initial lesion is usually confined to a hair follicle, sebaceous gland or sweat gland. It appears circumscribed and superficial. The skin is red, slightly swollen, œdematous, hard and tender for twenty-four hours. During the following day a central point, the size of a pin-head, becomes necrotic and appears yellow beneath the epithelium.

The treatment of this stage consists largely of "don'ts." Don't squeeze, don't pick, don't cut. One should carry a bottle of alcohol in his pocket and apply the alcohol to the infected areas every hour, or a drop of mercuriochrome may be applied two or three times a day. After another twenty-four hours the process is definitely localized in most cases. The necrotic area may be opened with safety. Alcohol or mercuriochrome may be applied, and resolution occurs.

The Second Stage—The second stage, the period of extension, develops when localization fails to occur, or as is usually the case, after the infected area has attracted the patient's attention, and either he or his family physician squeeze, pick or cut into it. Within twenty-four hours the infection invades the neighboring hair follicles and glands. A carbuncle is developing. A wide area of surrounding tissue is swollen, œdematous, infiltrated. Pain is intense. If a lip is involved it becomes two or three times its normal size. The skin is purplish red. About the central necrotic focus, the tissues are very hard and tender. If it has been opened there is almost no discharge. A small gray slough is visible. It seems to the writer that it is this condition which has led so many physicians into using a knife at once, and on finding no free pus to squeeze the tissues or to probe them. The early incision, squeezing and probing, not only fails to give relief but causes a further rapid spreading of the infection, and frequently results in a fatal thrombophlebitis of the facial vein, or septicæmia.

The treatment of the second stage is as follows.

Constitutional—The patient's powers of resistance should be reinforced by feeding. The local measures will insure rest, sleep, drainage and freedom from pain.

The local treatment is divided into two stages. During the first few days the one or more necrotic points are kept open, and compresses saturated in

4 per cent salt solution, are applied every hour and kept constantly wet day and night by fresh salt solution being added to the gauze with a dropper every fifteen minutes (The gauze is so small that it tends to dry in this time. Large gauze compresses are to be avoided because their weight interferes with the superficial circulation and also because large compresses are painful.)

The second stage of the treatment begins when the process has become localized and the process of liquifaction has advanced. This stage is recognized by a more abundant discharge. Now is the time when small multiple incisions may be made to connect the multiple openings toward the centre. Small bits of gauze are inserted to keep the skin edges apart, and to maintain drainage. The compresses are continued as before until healing has occurred.

By this method of *delayed operative interference* we confine our incisions to the walled-off zone, and we avoid cutting into veins which are not blocked, and lessen the chief danger of a carbuncle of the nose, upper lip, or upper part of the face, namely, septicæmia or a thrombophlebitis and embolism of the facial vein.

The Third Stage—If the patient is seen for the first time in the third stage of the process, with thrombosis of the cavernous sinus, meningitis or septicæmia, the case is, in all probability, hopeless. Nothing will be gained by multiple incisions, as illustrated by the case reports of Martin and Kahn.

If there is no cavernous sinus-thrombosis, but a septicæmia is present, the same local measures as described for Stage 2 should be applied, and the usual methods for combating a septicæmia instituted. Intravenous injections of gentian violet and mercurochrome have been suggested.

REFERENCES

- ¹ Treves, F. System of Surgery, vol. II, 1896
- ² Taylor, E. H. Applied Anatomy, 1904
- ³ Martin, W. ANNALS OF SURGERY, July, 1922, vol. LXVI, p. 13
- ⁴ Kahn, M. Journal Am. Med. Assn., March 29, 1924, p. 1043

EXPERIENCES WITH THE THYROID PROBLEM IN A DETROIT CLINIC^{*}

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For the year 1915, there are listed in the *Index Medicus*, 175 papers on the thyroid gland and its diseases. In 1920, there are 215 such papers listed, while in 1925, there are 510. One real discovery had just been made, and that was the discovery and isolation of thyroxin by Kendall (1914). Some refinements in operating technic have been reported but nothing of great moment. Definite progress has been made in the study of the metabolism of goitre patients, and this knowledge has been so thoroughly spread that there are few surgeons who care to operate on a sick thyroid patient without first having metabolism studies, which help so much in the judgment as to the proper time to operate. The revival of the use of iodine in the treatment of goitre—a treatment as old as the history of medicine—has added much to the success of the operative treatment of Graves' disease as well as in diminishing greatly the amount of colloid goitre. It not only aids in the prevention, but serves in the actual treatment of colloid goitre.

These thousands of papers on the subject of goitre in one decade are mostly concerning one new scientific discovery, refinements of operative technic, metabolism, anaesthesia, classifications—clinical and pathological—together with personal experiences of the authors. This literature is increasing with such an accelerating curve, that at this rate there will be produced within a short time a hundred papers a month on this subject. This is rather appalling to those who must cover the literature. Since the theoretically ideal state of a clearing house for knowledge, in which only papers with new facts would be worthy of publication, is not yet attained and might not perhaps be desirable, we find excuse for presenting to you this brief discussion of some of our experiences and to set before you a plea for earlier operation in the great group of adenomas of the thyroid.

Surgery has reached the stage where everything is done to save the small percentage of patients. We know that the great percentage of patients with appendicitis get over an attack without operation. Early operation is advised to save that small percentage who get peritonitis and die. After careful survey of the reported deaths, with or without operation, we believe that all patients who have adenomas of the thyroid should be advised to have such adenomas excised. We have come to this conclusion because the statistical studies from the various clinics, as well as our own results, show that the toxic adenoma cases are responsible for more than twice as many deaths as is exophthalmic goitre. Not only is the adenoma a menace on account of its potential toxicity, but it may also be regarded as a precancerous lesion.

^{*} Read before the Southern Surgical Association, December 15, 1926.

Carcinoma of the thyroid is far from being a negligible disease, and it usually arises in an adenoma. Precancerous lesions elsewhere in the body are regularly removed.

An early operation for adenoma or adenomata of the thyroid without symptoms or with very few symptoms should be as near danger-free as is any surgery. Its potential good is enormous. By some this is and will be regarded as a radical surgical idea, but by those of us seeing large numbers of patients with toxic thyroid adenomata, many of whom die needlessly early deaths, the idea is known to deserve serious consideration and discussion, just as did the idea of early operation for appendicitis. Even though a patient very ill with toxic adenoma comes successfully through the operative procedure, she or he has suffered irreparable damage to the heart muscle and undoubtedly has a diminished life expectancy.

Just at this point it might be well to give our experience concerning the use of iodine in the prevention of goitre.

About three years ago in Michigan there was a good deal of public propaganda about the prevention of goitre by the administration of iodine. In our clinic for some time before this, we had been using sodium iodide in the treatment of adolescent goitre and several hundred children, mostly females, were treated by us over a period of some years by the administration of sodium iodide in small doses for a period of three weeks, twice each year. The result of treatment by this method is most satisfactory and in practically all cases the goitre diminished greatly in size and has not since caused trouble. In a few cases we had acute iodine reaction in the thyroid, which, however, in a short time subsided.

In Michigan, the salt manufacturers put out table salt containing iodine. This has been introduced to the community through the grocers so that iodine table salt is in general use in Detroit. It was thought that in this way everyone would make up for the deficiency in our region in iodine intake. This is a rather uncertain method, however. Many people do not like salt in their foods and do not use salt as a condiment at the table, and even go so far as to insist on salt-free butter. One patient that I have with this idiosyncrasy against salt now has a colloid goitre. So it is seen that this method is not sufficient, as many of the population do not get iodine by this method.

Now the statistics which I am giving seem fairly conclusive in condemning this method of the distribution of iodine. It is known that an over-use of iodine results in activating adenomas of the thyroid and that it can produce an acute toxic condition. It is very probable that for this reason the use of iodine generally in the treatment of goitre fell into such disrepute with some of the leading medical men of the latter part of last century and the first part of this one. These statistics, obtained from our Health Department in Detroit, are most striking and suggestive.

The general use of table salt with iodine began in the latter part of 1924. The death rate in Detroit, as registered in the Health Department in the year 1916 showed the total number of goitre deaths as 17—a death rate of

2.44 per 100,000. The following year the death rate was 4.32, then the successive years it was 2.45, 3.99, 2.74, 3.07, 4.63, 3.71, with 4.16 in 1924. It was in this year that the general use of table salt with iodine was begun. The deaths from goitre in 1924, in Detroit, were 47, with a death rate of 4.16. In the next year, after this treatment had become generally used, the deaths showed a jump from 47 to 76, with a death rate of 6.1, and in 1926, which are completed up until the first of December and estimated for this month, they jump to 122 deaths with a death rate of 9.4. This may be a most distinct and perhaps alarming result of the general use of iodine without control. The only other possible explanation is that the physicians are as a result of this propaganda, using iodine injudiciously in the treatment of toxic adenoma and exophthalmic goitre. It is interesting to note that these deaths are divided in our Health Department as toxic goitre and simple goitre. The number of toxic goitres as shown by these statistics shows a change. The deaths in toxic goitres have increased in percentage from 2.26 to 8.5 per 100,000, whereas the simple goitre rate has decreased from 1.22 to 0.9. These statistics are most distinct in suggesting that the free use of iodine table salt should be discontinued, but I believe the controlled iodine dosage should be again substituted, for there is no doubt of its beneficial effect if used in this way.

We also use iodine in preparing our toxic goitre patients for operation. It is of the greatest value in reducing the time necessary for rest before operation, in both the exophthalmic cases and the toxic adenomata if they have not previously been treated with iodine, a practice which should be condemned. Our experience does not agree with some who advise against the use of iodine as a pre-operative measure in the toxic adenoma cases.

The simple or colloid goitres came to operation only on account of tracheal pressure, stretching of recurrent laryngeal nerves, or for cosmetic reasons.

The adenoma group have been operated on for the above reasons occasionally, but usually on account of toxic symptoms, *i.e.*, they showed definite signs of hyperthyroidism. The exophthalmic patients were operated on in practically every instance. The operation followed is that introduced and described by Dr. W. S. Halsted. In a good percentage of the cases a multiple stage operation was done. The usual anæsthetic used is ethylene gas. In an experience of over 600 goitre anæsthesias with ethylene, we conclude that it is well tolerated and that it exerts no stimulating or depressing influence on the heart.

A number of the patients operated on had previously been treated by Röntgen-ray or radium with some improvement, but with unsatisfactory results, not approximating in any way the results which we see in patients of a similar long-standing stage of development of the disease treated by operative measures.

Over 86,000 patients have had physical examinations in our clinic. These patients belong mostly to the private patient class. To determine the prevalence of goitre or its symptoms in such a group regardless of the complaint or diagnosis, we have made a survey of the first 50,000 patients. This is being

done by having a goitre card (see sample) for each patient. The different items as found positive are registered by punching. To get the cards of patients positive for any desired fact these cards are run through the sorting machine at the rate of 12,000 per hour. We will not bore you with many of these statistics now.

In the first 50,000 we had had 3092 patients with some enlargement of the thyroid, noted in the history. Of these 2564 were women, 528 were men—a ratio of about 5 to 1. The non-operative cases included in the above figures total 2667. Of these 2189 were women and 476 were men—a ratio here of about 4 to 1. The operative cases totaled 424, of which 375 were women and 49 were men—a ratio of nearly 9 to 1.

Of 17,250 patients coming to the clinic during the year 1925, 211 had operation for goitre—(a) simple or colloid, 23, (b) adenoma of all types, 101, (c) exophthalmic or hyperplastic, 79. Of this number 62 per cent only complained of goitre. We will to-day analyze only the work of this one year. Of these 211 operated cases, 55 per cent have been regarded as severely toxic and correspondingly grave operative risks, 30 per cent have been less toxic and 15 per cent had few or no symptoms of hyperthyroidism. Of the 118 very toxic cases, 55 per cent showed purely parenchymatous hypertrophy and hyperplasia, 31.5 per cent were adenomata, 4.2 per cent showed adenomata and hyperplasia, 8.5 per cent were colloid goitres and there was one case of tuberculosis of the thyroid. The 62 mildly toxic and the 31 non-toxic cases showed different percentages. Pure parenchymatous hypertrophy and hyperplasia was present in only 21 per cent, while 66.5 per cent were adenomata, 11 per cent were mixed adenoma and hyperplasia, 1 per cent was colloid and 1 per cent was normal thyroid. Of the 31 non-toxic cases 3.2 per cent showed pure hyperplasia and hypertrophy, 74 per cent were adenomata, 3.2 per cent mixed adenoma and hyperplasia, with a showing of 19.5 per cent of colloid goitres.

About one-third of these patients did not complain of goitre or were unaware that they had an enlarged thyroid. Of the patients on whom we operated, 80 per cent had toxic goitres and three of every four of these were grave surgical problems on account of severely toxic symptoms. A patient is never scheduled for operation until there is agreement between the cardiologist and the surgeon, and if there is present hyperglycæmia or diabetes—between the surgeon, cardiologist and our metabolism division head. Often, too, the neuropsychiatrist must pass on the probable benefits before operation. Our routine basal metabolic studies are made on all patients by the gasometer method of Tissot with gas analysis, as modified by Boothby and Sandiford. The usual twelve to fourteen-hour resting and fasting is demanded of the patient, and for a period of twenty to thirty minutes preceding the test he is also required to remain in complete relaxation in bed. Repeated observations of respiratory and pulse rate are made. The mask or mouthpiece is now adjusted and the expired air is collected in the gasometer for a period of at least five, but not more than ten minutes. Repeat examinations are

preferred and these are done on succeeding days rather than during the same day. It is often necessary to discard entirely the results of the first examination because of the apprehension of the patient and lack of complete cooperation. Part of the total volume of expired air is analyzed on the Haldane gas analysis apparatus, determining the percentage of carbon dioxide produced and oxygen absorbed. With the volume of air expired, the CO_2 produced, and oxygen absorbed, calculation of the basal metabolic rate is made, using the standards of DuBois.

The usual history of definite nervousness, palpitation, insomnia, irritability, loss of weight, fatigueability, with clinical symptoms of tremor, tachycardia, restlessness, flushing, etc., and with an increased basal metabolic rate—are all considered in evaluating the case. Palpation of the thyroid is of most importance in differentiating between adenoma and hyperplasia and even this is not always positive in making the diagnosis. It is remarkable if there are two separate diseases with symptoms so identical and equally variable.

A noteworthy difference recently in reports by various surgeons is that there are more deaths following operation on toxic adenomatous goitres than on the hyperplasias. This indicates to me only that there has been the long drawn-out intoxication, with the adenomatous group with great visceral degeneration due to this fact, and not to any essential difference in the disease process itself.

It is accepted by many that true hyperplasia or exophthalmic goitre is a disease—extrinsic to the thyroid—while adenomatous goitre with hyperthyroidism is intrinsic. With symptoms so nearly the same and with so much overlapping that the true diagnosis can be arrived at not from signs and symptoms, but from the history of duration and by pathologic examination of the thyroid, it must be that the above theory, that the one is intrinsic while the other is extrinsic, is not yet proven in spite of its wide acceptance. Whartin believes that both the adenomas and hyperplasias are part of a constitutional condition—*status thymolymphaticus*.

In our clinic, studies by our cardiologists show that in the severest heart conditions with auricular fibrillation present (in 100 such cases studied), 73 per cent were in adenoma cases and 27 per cent were in hyperplasia cases.

Some patients are considered entirely too ill to be operated on, and some in our clinic die without operation. We have deliberately operated on a few of these patients after thorough pre-operative preparation, patients whom we felt were surely going to die, and occasionally have had a most agreeable surprise in seeing a rapid improvement in the patient's condition. With everything possible done for these patients, care must be taken *not to have too much concern over our mortality statistics*, for an occasional patient may be lost who might have had his life prolonged by operation.

We do not feel that auricular fibrillation is a contra-indication to operation. In a recent group of thyroids studied by our cardiologist, twenty-two patients with fibrillating hearts were operated on with one death, and this death came later following a second stage operation. There was a group of eight with

fibrillation in hyperthyroidism who were treated medically. Four were admitted in extremis and soon died. The other four refused operation and continued to fibrillate in spite of measures of cardiac protection and digitalis medication.

Without operation these patients have very little to hope for beyond a few months or years of chronic invalidism. Of this group 41 per cent resumed a normal rhythm spontaneously. The average number of days before this occurred was twenty-five. Dr Janney Smith, our cardiologist, concludes that auricular fibrillation occurring in hyperthyroid patients is caused, or strongly contributed to, by a toxic factor, which gradually clears up after operation, allowing the normal sinus rhythm to become reestablished in almost half of the cases.

CONCLUSIONS

- 1 The use of iodine promiscuously in table salt in the effort to prevent simple goitre may be harmful.

- 2 The use of iodine controlled by regular dosage is of great value in the prevention or treatment of simple colloid goitre.

- 3 The use of iodine in the preparation of patients with hyperplasia of the thyroid for operation is of great value.

- 4 The use of iodine in the preparation of patients with toxic adenoma for operation has been of value in our clinic.

- 5 We advocate the removal of simple adenomas of the thyroid as a potential source of toxic hyperthyroidism, as well as for the fact that an adenoma may be a precancerous lesion.

- 6 Myocarditis with auricular fibrillation is not a contra-indication to operation.

- 7 Too much concern over mortality statistics may cost the life of an occasional patient who might, with operation, have had his life prolonged.

THYROIDITIS ACCOMPANIED BY HYPERTHYROIDISM*

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I AM not to discuss so-called toxic thyroiditis, nor suggest more than the possibility of such an entity accompanying the syndrome of Graves' disease. The pathological picture of the thyroid in a certain percentage of exophthalmic goitre cases is not dissimilar except in degree to that following the actual invasion of the thyroid by bacteria, with the accompanying inflammatory and hypertrophic and hyperplastic changes. Although no bacterial invasion can be demonstrated in the overwhelming majority of hyperplastic thyroids, the general theory of etiology through bacteria or their products is most interesting in considering a disease where the causes are almost entirely unknown. Many of these cases may be merely an expression of lymphatism.

Various investigators, notably Roger and Gairner,¹ Shimodaira² and others have, as far back as 1900, injected various bacteria into the blood stream and recovered them, respectively, in the thyroid gland. Tomellini,³ in 1905, drew the following conclusions, quoted by Mosimon⁶

(a) "The thyroid can become infected with experimental tuberculosis by direct injection of small masses of tubercle bacilli, just as other organs—the spleen, kidneys and testicles can become infected."

(b) "The susceptibility of the thyroid against tuberculous infection is less than in the other named organs."

(c) "The decreased susceptibility of the thyroid against tuberculous infection is probably united with the special functional activity of the gland."

The above quoted experiment would go to prove the possibility of a bacterial invasion of the thyroid, by way of the *blood route*. The reported cases, for example, cases one and two of my series, strongly indicate direct bacterial invasion *by contact* and possibly by the *lymphatic route*.

Riedel reported what he called iron-hard struma, in 1896. So-called primary tuberculosis of the thyroid gland was not reported before 1890. Voorhees, in 1914, reported a case of thyroiditis and remarked that, although there were several reported in German and French literature, the condition was not mentioned in any English text-book.

Mosimon's,⁶ in 1917, is the first comprehensive report I have been able to find on tuberculous thyroiditis and the first to point out a striking relationship between tuberculous thyroiditis and hyperthyroidism. Out of 9 cases reported, 5 cases, which had been previously diagnosed exophthalmic goitre, also showed hyperplasia, in 2 cases diagnosed mild or questionable exophthalmic goitre, were found hyperplastic areas. These 9 cases comprised less than one per cent of the operative material removed at the Crile Clinic at that time.

* Read before the Southern Surgical Association, December 16, 1926

Plummer and Biodeis,⁷ in 1919, reported 7 cases of tuberculosis of the thyroid gland, of which 5 cases could certainly be diagnosed hyperthyroidism and pathologically 6 of these cases showed hyperplasia. The greater the tuberculous involvement, the less severe the toxic symptoms and this fact was explained by the more extensive destruction of the gland. In 2 of the 5 patients with definite hyperthyroidism, the goitre was noticed before the symptoms, in 2 the opposite was true and in one, no thyroid enlargement had been detected. In the same article, Plummer remarks that chronic simple thyroiditis may give the same thyroid signs, but in the experience of the



FIG. 1—Case I. Abscess of thyroid gland before rupture into trachea.

Mayo Clinic, it has not been associated with hyperthyroidism. Likewise, Judd,⁸ two years later, in 1921, observed that simple thyroiditis may show symptoms of hyperthyroidism, to later disappear in the progress of the disease (destruction of thyroid elements).

The case of ligneous thyroiditis reported by Bohan,⁹ associated with high-grade dental infection, was in the beginning of the progress of the inflammation slightly thyro-toxic (pulse 104, tremor, metabolic rate

plus 26). The pathologic picture showed diffuse fibrosis and round-cell infiltration into apparently normal thyroid tissue. There were no hyperplastic areas found at a later date when the gland was studied. There was nothing to justify a suspicion of tuberculosis, syphilis or malignancy.

Up to July, 1924, according to St. George,¹⁰ reporting 3 cases under the heading of chronic productive thyroiditis (Riedel's iron-hard struma, benign granuloma of the thyroid (Ewing), or ligneous thyroiditis (Delore), the condition is referred to in only one English text-book, the case of Bohan one by Bruno Setitscheck and one or two references to French writers. Hashimoto, in 1912, reported several cases in which there was marked round-cell infiltration. Ewing has seen four of these cases. Cile has encountered 13 well-defined examples. At the Mayo Clinic 48 cases were found among 10,500 thyroidectomies. A progressive hyperthyroidism was not found to accompany this entity as described by Riedel and the pathological picture was usually a fibrosis replacement of the thyroid elements and round-cell infiltration. The condition is a chronic inflammatory process and it is quite

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conceivable that the same agent which initiates the cells to hyperfunction or dysfunction may, when it acts for a longer time, paralyze cell function

Searls and Bartlett,¹¹ May, 1926, group simple, non-specific thyroiditis into acute, subacute and chronic types and affirm that exophthalmic goitre may accompany all types. These two authors analyze a series of 17 cases and 20 cases, respectively, pointing out a contrast between the typical pathological picture of exophthalmic goitre and chronic non-specific thyroiditis with hyperplasia. In exophthalmic goitre, cells of the lymphatic series, grouped in the follicles or scattered between the acini are a part of the pathological picture (lymphatism), in chronic thyroiditis with hyperplasia, an advanced infiltration associated with desquamation and fibrosis gives a picture sometimes so dominating as to obscure an accompanying hyperplasia.

The question again comes up, as intimated in the first paragraph of this paper, as to the old discussion of thyroiditis and exophthalmic goitre or a hyperplastic gland with more or less lymphatism and accompanying degenerative changes in the thyroid elements.



FIG. 2 —Case I Abscess of thyroid gland after rupture into trachea

Last February, 1926, Watkins,¹² in a very scholarly paper, emphasizes the fact that the thyroiditis referred to in the older literature and assigned an importance in the various pathological states of the gland, such as exophthalmic goitre, come about through the assumption that the localized collections of lymphocytes with or without the development of germ centres, were evidences of inflammation, whereas, at the present time, these findings are looked upon merely as a part of thymico-lymphatic constitution, which these cases all show to a more or less degree.

A bacterial cause has been proven only in suppurative lesions and in such chronic processes as tuberculosis and syphilis. With the exception of woody or ligneous thyroiditis, milder inflammatory processes and even the cases of tuberculosis have not been demonstrated prior to pathological examination. In woody thyroiditis, bacterial cultures have not been recovered from the gland. The streptococcus and staphylococcus in Bohan's case of ligneous thyroiditis were cultivated from the teeth roots.

Davis¹³ reports seventeen recorded instances of gumma of the thyroid and points out a description of a diffuse thyroiditis syphilitica which is exceedingly rare. Two of my cases to be reported are of this later type, accompanied by exaggerated symptoms of exophthalmic goitre.

One might conclude with Plummer that "either a hypertrophic gland is rendered more susceptible to invasion by bacteria or the infection stimulates the parenchyma to an abnormal activity, and is thus inherently responsible for the hyperthyroidism with its attendant symptoms."

In a personal communication by letter with Harry G Sloan, of the Crile Clinic, he writes me in part as follows:

"We have learned to associate an infection in the pharynx, which we have found invariably to precede acute thyroiditis, and invariably find, when the thyroid is involved in an acute inflammation, that the patient gets a thyroid intoxication quite similar to that seen in Graves' disease."

"This acute thyroiditis not infrequently goes on to suppuration and within the last four years, I have had two typhoid abscesses from which we removed the organism, as well as four pyogenic ones where staphylococcus was found. The condition may subside with abscess formation, and then again we see the more

FIG 3 —Case II. Thyroiditis and cervical adenitis with first hyperthyroidism then myxœdema and ptosis

chronic type, merging into woody or ligneous thyroiditis, where the gland is as hard as cartilage and on exposure looks like cartilage—this may involve only one area of the gland or the entire gland. We do not ordinarily operate on ligneous thyroiditis if we can disprove its malignancy, with which it is so nearly to be confounded. The microscopic sections of it look as though every cell had been destroyed, yet we invariably find they make a full recovery, if let alone, without developing any signs of subsequent myxœdema."

Pemberton, of the Mayo Clinic, writes me, October 25, 1926:

"Inflammatory processes in the thyroid occur as the result of tuberculous and also non-tuberculous infections. In all the tuberculous cases which have come to operation, I have never seen more than seven or eight associated with hyperthyroidism, some of these were definitely associated with exophthalmic goitre. In the non-tuberculous variety

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there is often a history of preceding infection, usually in the tonsils, followed by pain and swelling in the region of the thyroid gland, although it is not uncommon to find painless swelling in any of these cases, without any preceding history of infection "

"In most instances we see thyroiditis in the chronic state, showing at operation the woody type of inflammatory reaction, at the time of examination this is usually unassociated with hyperthyroidism In many cases of thyroiditis of the acute or subacute variety there is a definite increase in the basal metabolic rate, and many of these have been diagnosed exophthalmic goitre My impression is that in a very high percentage of instances they go on to the development of myxœdema, presumably whether or not they are operated upon "

"In the above discussion, I have not included the cases of thyroiditis which are associated with exophthalmic goitre, for in about 10 per cent of all these cases the histologic section of the slides shows a picture of round-cell infiltration and fibrosis in a degree sufficient to diagnose thyroiditis In most instances these are of a mild degree, but not infrequently it is marked, and in about one-half of 1 per cent of the cases it is very marked These patients invariably develop myxœdema "

"At this time we have under observation one of our own nurses who, following a throat infection developed painful swelling in the neck Her metabolism went up as high as plus 30 Since then (two months) the swelling has entirely subsided and her metabolism is normal Sub-sidence of the inflammatory process in the gland and of the febrile reaction came about very rapidly following tonsillectomy "



FIG 4 —Case III Exophthalmic goitre tuberculous thyroiditis, after operation

CASE REPORTS

CASE I—Man, fifty-two, in good health up to time he developed influenza with bronchitis and cough for a week Cough more irritating and mass appearing over front of neck below thyroid cartilage, moving up and down on swallowing, which was done with difficulty The mass became larger, more sensitive and presented in the shape of the two lobes and isthmus of the thyroid gland At this stage the patient became nervous and tremulous, very weak, fast heart beat over a period of several days During this time the whole mass gradually softened, fever continued but patient was much relieved of tachycardia, tremor and weakness Incision of mass was advised and refused because he felt so much better Mass finally ruptured into the trachea and abundant pus was

coughed up, leaving the region of the neck almost flat. The patient was sluggish and inert for several weeks but finally reached his equilibrium, gained considerable weight and felt perfectly well again. This case was observed in 1912.

(In 1921, Gilman reported a similar case in which liquefaction involved the entire gland, including the isthmus, leaving only a shell of gland tissue within the capsule.) Figures 1 and 2 show the man photographed before and after rupture of the abscess into the trachea.

CASE II—An unmarried woman, twenty-eight years old, previously in splendid health, except for occasional attacks of tonsillitis, was taken with a severe infection of tonsils



FIG 5—Case V Exophthalmic goitre osteomyelitis Syphilis
After-treatment

and throat, the lymph glands, particularly on the left side of the neck, were enlarged, massed and very tender. Then appeared an enlargement over the lower front of neck. Almost overnight her eyes began to protrude markedly, her pulse became very rapid. The eyes protruded almost beyond the lids. She became too weak and nervous to rise out of bed. Her fever gradually subsided, her throat recovered, her tonsils were removed and finally and rapidly both lymph gland masses and the swelling over front of neck subsided, the eye balls retired in their protrusion and the much lengthened and thickened lids dropped in ptosis over them. Evidently the cervical sympathetic had been injured. The patient went rapidly into myxoedema and was only recovered by the use of thyroid extract for several months. A plastic operation was done

for the partial support of her eye lids. Figure 3 is a very poor photograph of her two months later.

CASE III—A married woman aged fifty, noticed the presence of goitre for two years, which had gradually increased in size. During the course of the last year her pulse has been very rapid, her eyes have become very prominent, loss of thirty or more pounds in weight, very nervous. The patient appeared as a thin woman, marked exophthalmos, general enlargement of thyroid gland somewhat hard, elastic and finely nodular on the surface. Afternoon temperature, 98, pulse, 120, respiration, 20 and blood pressure, 160/70. Marked tremblement and tremor of fingers, metabolism plus 46. After a short course of Lugol's and pulse of 90 all gland was removed under novocaine except a small portion of both upper poles, which appeared to be fairly normal gland. The removed portion was finely granular, very vascular and friable and uniform on the cut surface. The microscopic report was that, throughout, the gland was infiltrated with lymphocytes, minute tubercles and giant cells were found throughout the interstitial tissue. The

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follicles were infolded and lined by proliferating columnar epithelium. Diagnosis—Tuberculosis of Thyroid with Hyperplasia—Exophthalmic Goitre. The improvement in this case has been as revolutionary as any case of exophthalmic goitre. The healing was uneventful except for little discharge of pinkish serum. There has been return of pulse rate to 80, gain of weight, etc., July 15, metabolism was plus 46. December 11, metabolism is plus 24, temperature 98/6, gain of 32 pounds weight. Figure 4 is a photograph of patient at present time.

CASE IV—An unmarried girl, twenty-three years old, who developed a chancre on the gum after dental work, followed by mucous patches, secondary rash, palpable lymph glands, etc. About three months later was sent in with typical case of exophthalmic goitre. Symptoms of Graves' disease subsided rapidly under antiluetic treatment, tremor, swelling of thyroid disappeared and patient reached stage of good health and stability. She has remained well for eleven years. No metabolic rates were taken in those days.

CASE V—A widow, fifty-three years old. Osteomyelitis of the skull and left tibia. Typical exophthalmic goitre, positive Wassermann. Under antiluetic treatment symptoms of Graves' disease subsided rapidly. She was likely hyperthyroid for several months.

Sequestra were removed from skull and tibia. Wounds healed and patient remains quite well for fourteen years.

Also one case of tuberculous thyroid and two cases of ligneous thyroiditis without hyperthyroidism. These cases make up about $\frac{1}{2}$ per cent of my operative material and about $\frac{1}{4}$ per cent of my observed clinical cases.

CONCLUSIONS

(a) Thyroiditis is rare, probably $\frac{1}{2}$ to 1 per cent of all operative material and $\frac{1}{4}$ to $\frac{1}{2}$ per cent of all observed clinical cases.

(b) The two most frequent proven types of inflammation are tuberculous and woody thyroiditis. Syphilitic thyroiditis certainly occurs. Non-specific thyroiditis has shown its bacterial cause in some suppurating cases.

(c) Hyperthyroidism may accompany any type of thyroiditis at any stage, usually the subacute stage. The relation in tuberculous thyroiditis is striking.

(d) Most cases of non-specific and woody thyroiditis finally become hypo-thyroid whether operated on or not. (Difference of opinion as to this point at the Crile and Mayo Clinics.)

(e) Cases of tuberculous thyroiditis operated on have given the best functional lasting results. Syphilitic thyroiditis has been relieved with appropriate treatment.

(f) Therefore the more slowly progressive and destructive type of inflammation is more apt to be accompanied pathologically by hyperplasia and signs of hyperthyroidism and is more apt to give better functional results after operation.

(g) The usual amount of thyroid should likely not be removed, even in tuberculous thyroiditis, for at least one case out of thirteen has resulted in myxoedema.

REFERENCES

¹ Roger and Garnier. *Arch. gen. de Med.*, 1900, vol. clxxxv.

² Shimodaira. *Deutsche Ztschr. f. Chir.*, 1911, vol. cix.

³ Tomellini. *Beitr. z. Path. Anat. u. z. allg. Path.*, Jena, 1905, vol. xxviii, p. 590.

- ⁴ Riedel Verhاندl d Dtsch Ges f Chir , 1896, vol xxv, No 1, p 101
- ⁵ Voorhees Med Record, November 21, 1914, vol lxxvi, p 883
- ⁶ Mosimon Surg, Gyn and Obstet, 1917, vol xlv, pp 680-693
- ⁷ Plummer and Broders Mayo Clinics, 1919, p 504
- ⁸ Judd Mayo Clinics, 1921
- ⁹ Bohan Med Clinics of North Amer, vol vii, January, 1924
- ¹⁰ St George ANNALS OF SURGERY, July, 1924
- ¹¹ Searls and Bartlett Cal and West Med, vol xlv, May, 1926
- ¹² Watkins Annals of Clin Med, vol iv, No 8, February, 1926, vol vii, p 273
- ¹³ Davis Chicago Path Society, 1907-1909
- ¹⁴ Sloan Crile Clinic, Personal Communication, October 7, 1926
- ¹⁵ Pemberton Mayo Clinic, Personal Communication, October 25, 1926

PRIMARY ENDOTHELIOMA OF CERVICAL LYMPH-NODES*

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ALTHOUGH the medical profession generally thinks of primary endothelioma of cervical lymph-nodes as almost a curiosity, because of its rarity, Ewing, as early as 1913, and Jean Oliver since then, have asserted that the disease actually is much more prevalent than is commonly supposed. I personally have recognized it in only one instance, and then by biopsy, and in that case the disease resulted fatally. This one experience has sufficed to convince me that an early diagnosis of the disease (which I now realize would have been possible in that case), followed by a complete extirpation of it surgically while the condition is still local, will reduce fatality. At this time it is possible to recognize the disease only by biopsy, and to do so in that manner requires the services of a highly competent pathologist. Since it is at least possible histologically to differentiate the disease now, it can reasonably be expected that in due course it will become possible clinically to recognize the disease. Accordingly, the little I have by experience learned of the disease I propose to incorporate in this paper, in the hope it will be of service to some one who eventually can develop and publish a clinical picture of the disease.

Before reporting the solitary case that has come under my observation, it is proper briefly to summarize the published data on this subject. In 1869, the term "Endothelioma" was introduced by Golgi. For a long time afterward it was a debated question whether tumors actually originated in endothelium.

In 1880, Chambard described a primary cancer of lymph-nodes originating in endothelial cells, and in consequence he may properly be called the discoverer of primary endothelioma of the lymph-nodes. In his report he described a local form involving one node or one chain, and a generalized form that quickly resulted fatally. Thenceforth, and until 1913, primary endothelioma of the lymph-nodes was simply a medical curiosity having virtually nothing but theoretical interest.

In 1913, Ewing published a monograph entitled "Endothelioma of Lymph-nodes" reporting a series of cases, and with that paper the subject first acquired clinical importance. He somewhat boldly asserted that the disease is a rather common neoplasm, differing histologically, anatomically and even clinically from all other diseases, and especially secondary carcinoma, lymphosarcoma and Hodgkin's disease, which are the diseases with which it is still most often confused.

* Read before the Southern Surgical Association, December 15, 1926

In consequence of the studies and reports of Ewing, Oliver, and others, we now know definitely that primary endothelioma is actually a distinct disease somewhat frequently arising in the lymph gland structure in the neck, the axilla, and the groin. We know, too, that at its inception and thereafter for a varying length of time it is occasionally a truly local condition admitting of complete cure if it involves accessible glands susceptible to surgical extirpation. We further know that the disease eventually becomes generalized and is then necessarily fatal, and as a consequence, the sooner its existence

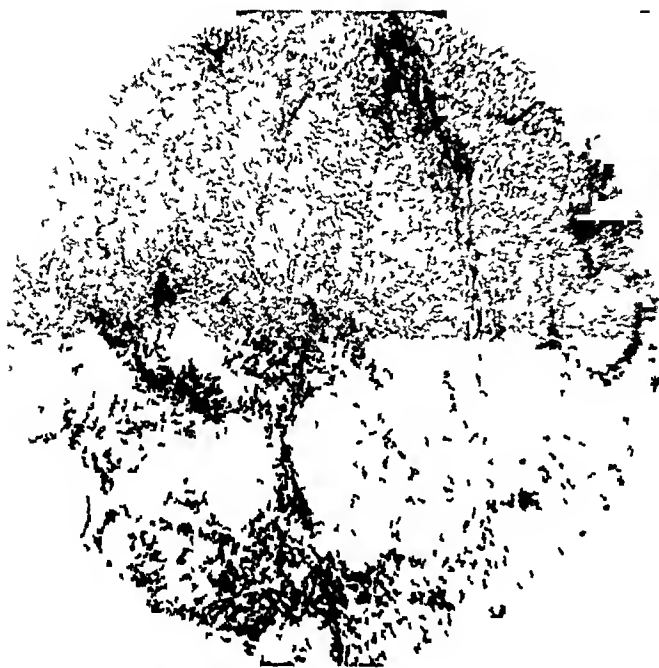


FIG 1—Primary endothelioma of cervical lymph-nodes. Low power showing multiple foci of tumor tissue surrounded by intact lymphoid tissue of the lymph-node

is recognized and it is treated, the more favorable will the prognosis be.

Although we have all this theoretical knowledge, its application in practice is one of the most difficult tasks confronting the surgeon. Primary endothelioma of cervical lymph-nodes has been, and can be, definitely differentiated. However, in many respects its manifestations are closely similar to those in other diseases, notably in acute infectious adenitis, tuberculosis, syphilis, secondary lymphosarcoma, and Hodgkin's disease, and clearly to differentiate it from them all

requires painstaking collaboration of diagnostician, pathologist, and surgeon.

Acute infectious adenitis of cervical lymph-nodes usually manifests itself in tonsillar infection, abscessed teeth, and ulcer of the scalp, or of the mucous membrane of the mouth or pharynx. The presence of infection in any of these specified areas with reasonable certainty thus explains a glandular enlargement in the cervical region.

Tuberculosis, when manifested in the cervical lymph-nodes, appears first in the sub-maxillary lymph-nodes, and soon afterwards the cervical glands in both sides of the neck become enlarged and continue to grow slowly, and the postcervical, supraclavicular and scapular systems and the bronchial lymph-nodes become affected. Associated rise in temperature and tenderness in the glands, which never characterize primary endothelioma of the cervical lymph-nodes, commonly occur in the presence of tuberculosis. In tuberculosis too, the superficial cervical glands have a tendency to caseation and sinus formation.

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For differentiation of this disease and syphilis, a Wassermann usually suffices

In secondary carcinoma, the primary lesion is usually located in the mouth or pharynx and where the primary lesion is so located secondary carcinoma can with reasonable safety be diagnosed

The real test of diagnostic skill lies in differentiating primary endothelioma of cervical lymph-nodes from Hodgkin's disease and lymphosarcoma of the cervical lymph-nodes

Hodgkin's disease almost invariably manifests itself first in the lymph glands of one or both cervical regions and quickly thereafter a general adenopathy succeeds. The affected glands remain discrete but become enlarged. This disease is thought to be due to infection and for this reason it may become very painful early in the course of the disease. Metastasis to the viscera with resulting pressure symptoms is a common phenomenon in the course of the disease. Though chronic, this disease is characterized by remissions. Surgery is futile in its treatment and the disease terminates fatally at the end of two and one-half or three years.



FIG. 2.—High power showing areas of lymphoid tissue adjoining the endothelioma and giving a comparison in size and staining properties of the tumor cells with the persisting lymphoid cells

Primary endothelioma of cervical lymph-nodes manifests itself first in either the superficial or deep lymph glands of the anterior or posterior cervical regions just as Hodgkin's disease does. Unlike that disease, it invariably manifests itself unilaterally and general adenopathy does not succeed, at least until the late stages. Although the glands remain discrete and become enlarged they do not become painful until the late stages of the disease. Metastasis to the viscera is an extremely rare phenomenon. Remissions do not characterize the disease, but it is consistently progressive. Surgery, while futile and even aggravative of malignancy in the advanced stages of the disease, may in its early stages accomplish a complete cure.

Lymphosarcoma of the cervical lymph-nodes is easily and commonly confused with both Hodgkin's disease and primary endothelioma of cervical lymph-nodes. Between it and the last named disease instant clinical differentiation is simply impossible as the two have almost identical clinical history and physical findings. Fortunately in the early stages of both diseases similar courses are run and to the same treatment both should be subjected. However, lymphosarcoma of the cervical lymph-nodes tends early to involve the

glands of both sides of the neck and to metastasize first to the supraclavicular regions and then to the mediastinum, and thus, and thus alone, will extended clinical observation admit of differentiation of the two diseases. Such differentiation, while academically interesting, necessarily comes too late to be practically helpful. In consequence, biopsy alone in our present state of knowledge accomplishes any practicable differentiation of these two diseases, and is the only really reliable basis for diagnosis where the presence of either of the three is suspected, and where such presence is suspected, the removal

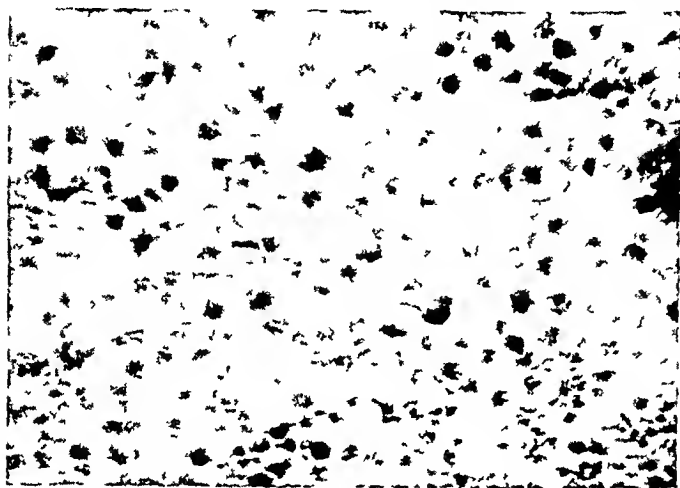


FIG 3 —High power showing details of the tumor cells

of a gland or the tumor for microscopic section and diagnosis should be made at the earliest possible moment.

If the microscope reveals endothelioma, the patient should if possible promptly be subjected to a radical block dissection of the cervical glands, and if he is, there is a fair chance of curing him. Of course, in lymphosarcoma, Hodgkin's disease and

secondary carcinoma, surgery avails little, if indeed any. It is highly important to note that even by microscopic examination the differentiation in many cases is extremely difficult.

Among the highly distinguished students in this general field is Dr Wm B Coley of New York, and as an evidence of the difficulties involved in diagnosing this disease I cannot forbear taking the liberty of quoting at length from a purely personal communication recently received from him. In part he says

In my opinion, based on an observation of a clinically considerable number of cases of tumors of the lymph glands, it is impossible to make a differential diagnosis between endothelioma and lymphosarcoma. Also, I believe in most cases it is extremely difficult to differentiate Hodgkin's disease from lymphosarcoma, not only clinically, but often microscopically as well. I have had cases in which one pathologist has classified the disease as lymphosarcoma, and another pathologist of equal standing has called it Hodgkin's disease. In some of my own cases a microscopical diagnosis of lymphosarcoma has been made at one time, and a little later on, the same pathologist has called it endothelioma. Cases in which it is possible to make a diagnosis of primary endothelioma of the cervical lymph glands, I believe, must be extremely rare.

One of the few cases that I recall in my own experience, in which a definite pathological diagnosis of primary endothelioma of the cervical lymph glands had been made, was seen clinically by one of the leading surgeons of Chicago, who pronounced it definitely inflammatory gland from infected teeth. The patient had a number of teeth extracted, without benefit. The surgeon still believing in the correctness of his diagnosis, sent the patient south for a number of months. When he returned, it was found that the

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gland had increased considerably in size, it was then removed, and proved to be a primary endothelioma of the cervical lymph glands. In spite of thorough surgical removal, it recurred promptly. When the patient consulted me, he had a hopelessly inoperable malignant tumor involving the left cervical region as far as the clavicle. In spite of radium and toxin treatment, the disease gradually spread by infiltration, until it involved a large part of the pectoral region as well as the scapular and subscapular region, forming a huge tumor with an area of ulceration in the centre. At the end of a year and one-half, it killed the patient by exhaustion.

The foregoing quotation demonstrates the impossibility of clinical diagnosis and is a caveat of the unreliability of microscopic section as a basis for diagnosis of this disease. Notwithstanding his profound respect for Doctor Coley's matured judgment, the writer believes that microscopic section by a competent pathologist does admit of the definite diagnosis of the disease.

On section the nodes present a moist, firm, friable, grayish-white, smooth surface that changes with variance in the degree of fibrosis or

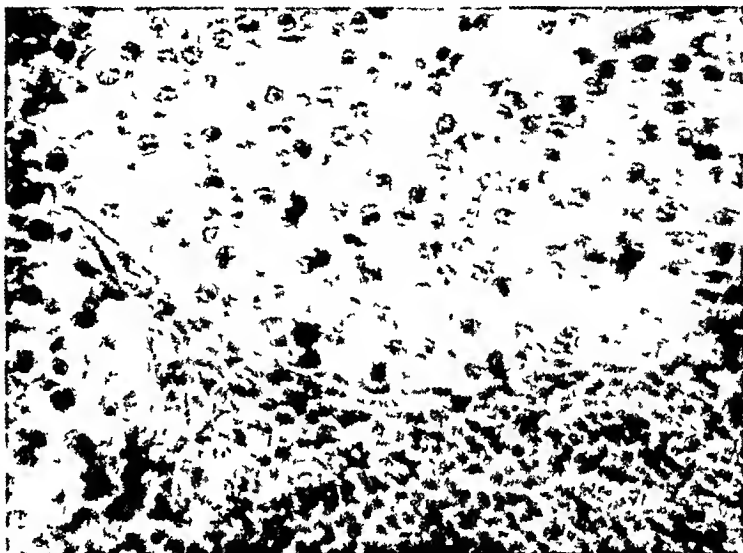


FIG 4—High power showing margin of the tumor mass and the adjoining lymphoid cells

necrosis. The capsule is apparently intact, somewhat thickened, and infiltrated with lymphoid cells. The lymphoid structure of the node is largely lost, although there are areas of fairly dense lymphoid structure, with small blood-vessels, connective tissue cells and large endothelial cells of the same type that make up the main part of the new growth. The general structure is alveolated, the alveolar walls being of various thicknesses of connective tissue cells in all stages and carrying small blood-vessels. The contents of the alveoli are typically large rounded or polyhedral cells with fairly definite cell outlines and nucleus of vesicular type, with prominent basic staining nucleoli, occupying from one-half to three-fourths of the cell. The cytoplasm of the cell is clear. The alveoli are of various sizes and the contained cells appear to spring from the lining. In the centre of the alveoli, particularly the larger, the cells are shrunken, with opaque, deep acid-staining cytoplasm and small dense nuclei (pyknotic). Occasionally there is a central blood-vessel from around which the endothelial cells radiate, giving the appearance of perithelioma, these, however, seem to be simply projections of ruptured alveolar walls as rupture seems to have occurred frequently in the distended alveoli. In some areas the cells are flattened and dense, as from pressure, giving the appearance of carcinoma. The foregoing is the typical and general appearance of primary endothelioma of lymph-nodes as revealed by the microscope.

If through biopsic diagnosis the existence of primary endothelioma of cervical lymph-nodes is once established, choice must be made between two courses that alone are available as methods of treatment palliation by X-ray, radium, and Coley's toxins, or extirpation by surgery. Highly matured judgment should be invoked in making this seemingly simple decision. If the locus of the disease because either of deep seatedness or its generalization does not admit of the complete removal of all diseased tissue, do nothing except palliate. To operate in such a case will surely produce malignant recurrence and hasten the death of the patient. If the locus of the disease does admit of the complete removal of all diseased tissue, an operation should be resorted to immediately, and if properly performed will probably result in a complete cure.

CASE REPORT—In March, 1925, I was consulted by a man twenty-six years old and six feet tall who weighed 210 pounds. He asserted he was in excellent health until two years before when he first noticed a small, hard, painless lump near the angle of the jaw in right side of neck. This mass enlarged slowly without symptoms during the succeeding sixteen months until it attained the size of a bird's egg and he consulted a physician who attributed the enlargement to tonsillar infection or infected teeth. In the month following, August, 1924, seven months previous to the date I was consulted, a tonsillectomy was performed and an impacted tooth and three or four other teeth were removed, all without any apparent beneficial consequences. To me he complained of weakness and loss of appetite and he called to my attention a tumor in the right side of his neck. This tumor, of the size of a walnut, was hard, slightly irregular, rather freely movable, and not adherent to the skin, and gave no evidence of either redness or oedema. A careful search failed to reveal a primary tumor in mouth, pharynx, or elsewhere. I noted the lower cervical chain and posterior cervical glands were enlarged to the size of marbles and that the supraclavicular glands were palpable. An X-ray of the chest disclosed some enlargement of the hilus and bronchial nodes. The Wassermann reaction was negative. The urine was negative. Blood showed moderate anemia, Hemoglobin 80 per cent, leucocytes 8000, polymorphonuclears 80 per cent, small lymphocytes, 14 per cent, large lymphocytes, 4 per cent, eosinophiles 1 per cent, and transitionals 1 per cent. Temperature 98, pulse 76, respiration 20. March 13, 1925, under gas anesthesia, a gland was removed for pathological study. A diagnosis of "Primary Endothelioma of Cervical Lymph-nodes" was made.

In the subsequent course of the disease the patient lost weight and strength, suffered from shortness of breath, and an annoying cough that was attended by expectoration of mucopurulent blood-tinged sputum, and ultimately a metastasis to the left breast developed, though no metastasis to the abdominal cavity ever took place. X-ray picture of his chest made several weeks after the diagnosis showed the metastasis more advanced than in the previous X-ray of his chest made previously thereto. The patient received X-ray treatments but the disease progressed steadily without any apparent retardation from this source. He died in September, 1925, two years and six months after the first small, hard, discrete nodule was noted in the right side of his neck. Although an autopsy was urged, the family objected seriously, and it was not performed, which, from the scientific viewpoint is unfortunate.

CONCLUSIONS

- (1) Primary endothelioma of the cervical lymph-nodes is a more common neoplasm than is generally supposed.
- (2) The disease is limited to one or a small group of glands, more com-

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monly the superficial cervical lymph-nodes of the anterior triangle than the more inaccessible cervical glands

(3) Biopsy is the only reliable method of diagnosis at this time and even that requires the services of a highly competent pathologist

(4) A suspicious tumor of the neck should always be subjected to biopsic diagnosis early in its development

(5) Primary endothelioma of the cervical lymph-nodes is now a pathological entity and should become a clinical entity

(6) If an early diagnosis of primary endothelioma of the cervical lymph-nodes is once definitely made and it is determined same is not the generalized form, an operation should be resorted to immediately, and if properly performed will probably result in a complete cure

REFERENCES

- ¹ Ewing Journal Medical Research, vol xxviii, May, 1913
- ² Oliver Journal Medical Research, vol xxiv, December, 1913
- ³ Mitchell Journal Medical Research, vol xxiv, November, 1910
- ⁴ Kettle and Ross The Lancet, May, 1921
- ⁵ Coley Transactions of American Surgical Association, 1915
- ⁶ Coley Personal Communication, 1926

BENIGN TUMORS OF THE STOMACH*

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BENIGN tumors of the stomach are of rather unusual interest to the surgeon since they may be the cause of serious complications, may easily be overlooked in the course of a routine examination, and can be dealt with only by surgical means. While they are infrequent, as compared to other tumors of the stomach (Eusterman has shown that less than half of one per cent of gastric neoplasms are benign), they are encountered sufficiently often to make it imperative to exclude them in every case of unexplained indigestion, and of obscure chronic anæmia particularly. In a recent comprehensive article, Elason and Wright have reviewed the cases in the literature and discussed fifty of their own, four of which were found at operation. Eusterman and Senty, in 1922, reported a series of twenty-six surgical cases at the Mayo Clinic, the present study is based on fifty-eight cases which have come to operation at the Clinic up to this time.

In this series there were thirty-five cases of benign tumor of the stomach in males and twenty-three in females. The average age of the patients was forty-six years, the youngest was eight years old and the oldest sixty-nine. Sixty-nine per cent of the tumors were in the pylorus, 26 per cent in the body of the stomach, and 5 per cent in the cardia. The cases are grouped according to the type of tumor as follows:

Fibro-adenomatous polyps	14
Adenomas	4
Fibromas, myomas, fibromyomas, adenomyomas, myofibromas	23
Hæmangiomas	4
Polyposis	4
Hypertrophied mucosa	2
Papillomas	1
Dermoid cysts	3
Hypertrophied pyloric muscles	3
Total	58

The tumors varied in size from 5 mm to one weighing 1000 gm, a dermoid cyst filling the lesser peritoneal cavity. In forty-five of the fifty-eight cases the tumors were single, and in thirteen they were multiple, including the four cases of polyposis. In twenty-two cases the tumor was associated with other lesions: in five with carcinoma of the stomach, in four with gastric ulcer, in six with duodenal ulcer, in five with cholecystitis, in one with chronic appendicitis, and in one with carcinoma of the cæcum. Malignant degenera-

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tion was found in only two of the tumors, one a polyp and the other a pedunculated adenoma. Ulceration could be demonstrated in 17 per cent of the tumors.

SYMPTOMS

Benign tumors per se are symptomless unless complicated by bleeding, ulceration, intermittent obstruction of the pylorus, or interference with gastric motility and secretion due to the size or extent of the tumor. It is exceedingly important to detect those tumors that are responsible for symptoms, and it is fortunate that they can usually be detected by fluoroscopic examination.

The most frequent and the most important sign of benign tumor of the stomach is anæmia. This is usually of the secondary type, but in long-standing cases the anæmia may progress to a point suggestive of the primary type. There are instances in this series in which a diagnosis of pernicious anæmia was made before operation and disproved after the removal of the tumor. Gross hemorrhage has resulted in acute secondary anæmia in a number of cases.

Pyloric obstruction, usually intermittent, occurred in 10 per cent of the cases. The tumors were usually attached to the posterior wall and, either because of a long pedicle or a redundant mucosa, could be invaginated through the pyloric orifice. From roentgenologic examination one tumor appeared to be entirely within the duodenum and to have its origin there, but exploration showed its pedicle to be on the gastric side of the pylorus.

The symptoms of indigestion of varying degree exhibited in certain cases may simulate those of peptic ulcer, or may be so irregular that no diagnosis can be ventured. Of the cases unassociated with other lesions dyspepsia in some form was noted in 20 per cent. A careful consideration of the type of indigestion found in these cases does not reveal a syndrome on which a diagnosis of benign tumor could be made.

In the series of cases discussed here the only physical findings suggestive of benign tumor occurred in those cases in which the tumor was large enough to be palpated. In only eight was this possible, but in none of these was a clinical diagnosis of benign tumor made independently of the roentgenologic examination. Differential diagnosis is almost entirely dependent on fluoroscopic examination. Seventy-five per cent of all the patients had been examined by the Röntgen-ray. In 92.6 per cent of these the roentgenogram revealed the lesion, and in 48 per cent the lesion was reported to be a benign tumor.

TYPES OF TUMOR

While the various types of tumor are not distinguished by characteristic differences in symptoms, it is at least of interest to review some of the findings associated with the different type.

Fibro-adenomatous Polyps—Of the fourteen cases of gastric polyp nine were cases of single and five of multiple polyps, there being twelve distinct polyps in one case. In size they varied from 6 mm. in diameter to 8 cm. long by 2.5 cm. wide. One was on the anterior wall, and four on the posterior wall.

of the body of the stomach, and nine on the posterior wall in the pyloric region. This type of tumor was more common than any of the other types in patients who had other gastric lesions. Five were associated with carcinoma of the stomach, one with gastric ulcer, one with chronic duodenal ulcer, and one with a hypertrophied pyloric muscle causing obstructive symptoms.

The symptoms in the cases in which there were lesions of the stomach other than the polyps were due to the former rather than to the latter. In the six cases in which there was no associated disease, the chief sign was that of anæmia. In five the anæmia was marked, the hæmoglobin in one case being reduced to 32 per cent and the erythrocyte count to 1,480,000. The blood findings in three of the cases were suggestive of pernicious anæmia. In one the color index was 1.4, the hands and feet were numb, and a diagnosis of early combined sclerosis was made. This patient was given two transfusions, and about six weeks later returned to the Clinic much improved. On examination at this time the lesion of the stomach, which had been revealed by fluoroscope at the first examination and thought to be an inoperable carcinoma, was suspected of being a benign tumor. At operation I found multiple polyps on the posterior wall of the stomach, and following their removal the symptoms promptly disappeared and the blood findings improved.

Another patient had tingling in the lower extremities and had received a transfusion a month before coming to the Clinic. Examination here showed that the hæmoglobin was 38 per cent, the erythrocyte count was 3,270,000 and the color index 0.5. In all six of the cases of polyps uncomplicated by other disease no free hydrochloric acid was found, which was additional confusing evidence, particularly in differentiating pernicious anæmia, gastric carcinoma, and benign tumor. In five of the six cases the polyps were pedunculated, and one attached near the pylorus had become invaginated 7.5 cm into the duodenum. Another which arose at the pyloric ring could be moved down into the duodenum or up into the stomach. The pathologic report on one of these polyps, approximately 7 cm in diameter, situated in the cardiac portion of the stomach, was suggestive of malignant degeneration. Although the tumor was rather inaccessible, I was able to remove it by cautery amputation at the pedicle. The patient also had an enlarged spleen and was advised to undergo splenectomy following removal of the polyp. Four months later the patient returned to the Clinic giving a history of recent loss of weight and continued anæmia. Removal of the spleen was again advised but exploration disclosed a carcinoma extending into the extragastric tissues and apparently originating at the site of excision of the tumor.

In five of the six cases in which anæmia was associated with the polyps a pre-operative diagnosis was made by the roentgenogram. In one case the roentgenogram was negative, when the polyp was excised it measured only 11 by 8 mm. Associated symptoms were rather indefinite. Three patients had experienced gastric distress over periods varying from six months to forty years but in no case was the distress marked or suggestive of an intragastric lesion.

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Adenomas—In the four cases of adenoma three of the tumors were found near the pylorus and the fourth on the anterior wall near the middle of the stomach. These tumors varied from a fraction of a centimetre to 6 cm in diameter. The history in each case was suggestive of ulcer, although no ulcers were demonstrated. One of the patients showed a severe degree of anæmia and had been treated for pernicious anæmia. A blood examination at the Clinic showed the hæmoglobin to be 27 per cent and the erythrocyte count 3,080,000. After two transfusions the hæmoglobin was 50 per cent. This tumor was diagnosed pre-operatively by roentgenograms, and at operation was found to be pedunculated and measured 6 by 4 by 3 cm.

Fibromas, Myomas, and Similar Tumors—Of the group of twenty-three fibromas, myomas, fibromyomas, adenomyomas, and myxofibromas nine were found to be associated with other conditions of sufficient importance to account for the symptoms, the benign tumors being found secondarily. Of the others, the history in seven was suggestive of ulcer, although three patients had no dyspepsia but recurring attacks of hæmatemesis and melena. In only two cases of the entire group was free hydrochloric acid absent. In twenty of the cases the tumors were single and in three they were multiple. Ten of the tumors were found in close proximity to the pylorus, two in the antrum, two in the midgastric region, and one in the cardiac end of the stomach. Two of the tumors were subserous and varied from 1 to 6 cm in diameter. Five of the tumors were responsible for varying degrees of obstruction, and one, 5 cm in diameter, had herniated through into the duodenum for a distance of 12.5 cm, producing an intussusception. One tumor, 3 cm in diameter, was also pedunculated and had herniated through the pylorus. One, only 1.5 cm in diameter, produced almost complete obstruction. Six of the twenty-three tumors in this group were ulcerated on the surface but none showed evidence of malignant degeneration.

Hæmangiomas—Three of the four patients with hæmangioma had suffered from slight dyspepsia, and the fourth from recurring attacks of diarrhoea. The outstanding features of this group, however, were the previous occurrence of melena in three cases and of severe hæmatemesis in one. In only one case was gastric acidity abnormal, there was no free hydrochloric acid. The hæmoglobin in two of the cases was 44 and 47 per cent, respectively. The tumors varied from 2.5 to 6 cm in diameter, and the largest weighed 108 gm. They were all single and pedunculated. Two were ulcerated and none had undergone malignant degeneration.

Polyposis—Three of the four patients with polyposis gave histories of distressing dyspepsia lasting over periods of from four to six years, in one of these cases gastric ulcer was associated and, in the fourth, glossitis. The latter had been diagnosed pernicious anæmia at the Clinic nine months before polyposis was diagnosed. In three of the four cases there was an absence of free hydrochloric acid. The highest estimation of total acidity for the group was 22. In two of these cases nearly the entire area of the stomach was involved. These were both diagnosed by the roentgenogram. A case

which I reported in 1919 was a striking example of the dependability of the rontgenogram in making possible the recognition of such cases. In one case in this group there was a mass of polypoid mucosa, 5 by 8 cm., which could be invaginated into the duodenum.

Hypertrophied Mucosa—There were two cases of hypertrophied mucosa. They did not seem worthy of the name polyposis because of the absence of the characteristic multiple polyps which are the basis for the classification of polyposis. In one of these an area of hypertrophied gastric mucosa in the fundus of the stomach had been associated with symptoms of ulcer for more than three years. Although the patient had a history of melena, there was no evidence of marked anæmia. There was no free hydrochloric acid, and the rontgenologic picture was that of polyposis. This area of hypertrophied mucosa could be easily moved into the pyloric region and was readily excised by clamp and cautery.

Papilloma—There was one case of papilloma in which there was a moderate degree of anæmia and also multiple tumors of the jejunum. These were not removed but in all probability they were papillomas. The patient also had duodenal ulcer.

Dermoid Cysts—There were three patients with dermoid cysts, only one of whom had a history of gastric disturbance. This patient had had repeated hemorrhages (both hæmatemesis and melena) for about two years. The hæmoglobin was 40 per cent. In one case a cyst was situated on the posterior wall of the stomach and was removed by partial gastrectomy. In another case the cyst on the lesser curvature was found secondarily, during an operation for gall-stones. The third case was that of a boy aged eight with a dermoid cyst weighing 1000 gm. on the posterior wall of the stomach. The cyst with a portion of the gastric wall was resected.

DISCUSSION

In the fifty-eight cases of benign tumor of the stomach encountered at operation the tumor was removed in fifty-seven, and exploration only was carried out in one case, that of polyposis involving the whole stomach. Patients with marked anæmia were given sufficient transfusions to raise the percentage of hæmoglobin to a satisfactory level and, when necessary, the operation was performed under local anæsthesia. Of the thirty-six cases in which the tumor was the only lesion, the tumor was removed by excision alone in seventeen, and in the remainder (except in the case of exploration) the segment of the stomach containing the tumor was resected. The situation of the tumor determined the best method of approach. The procedure used most frequently was transgastric excision through an incision in the anterior wall, and division of the pedicle by the cautery. In the larger tumors the possibility of malignant degeneration makes partial gastrectomy advisable, I have had at least one case in which carcinoma developed at the site of the attachment of the pedicle.

BENIGN TUMORS OF THE STOMACH

In the uncomplicated benign tumors there was no operative mortality
In a case in which the primary condition was carcinoma of the stomach, death from bronchopneumonia occurred six days after operation

BIBLIOGRAPHY

- ¹Balfour, Donald C Polyposis of the Stomach Surg, Gynec and Obst, 1919, vol xxviii, pp 465-467
- ²Eliason, E L, and Wright, V W Benign Tumors of the Stomach Surg, Gynec and Obst, 1925, vol xli, pp 461-472
- ³Eusterman, G B, and Senty, E G Benign Tumors of the Stomach Surg, Gynec and Obst, 1922, vol xxxiv, pp 5-15

UNILOCULAR CYST OF THE SPLEEN[†]

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ALTHOUGH reports of non-parasitic cysts of the spleen had appeared in the literature at various times, it was not until 1904 that any great interest was taken in the subject. At that time articles by Heinrichius, Monier, and Lasperes appeared in Germany and in the following year Bryan made his contribution. In 1906, Powers collected thirty-two cases and in 1913, Fowler enumerated eighty-five cases of non-parasitic cysts of the spleen and added one of his own. By 1921, five additional cases had appeared in the literature and were again compiled by Fowler. In the past five years reports and studies by Pribram, Gosselin, Moynihan and others have added to our knowledge of the subject.

Non-parasitic cysts of the spleen have been grouped by Fowler in the following manner:

1 True cysts *a* Infolation cysts (inclusions of the peritoneum, inflammatory or traumatic), small and multiple, may be superficial or deep.

b Dilatation cysts—polycystic disease of the spleen resulting from dilatation of the splenic sinuses. Multiple.

c Neoplastic cysts as lymphangioma or hæmangioma. Often it is impossible to differentiate these from the previous type.

2 Pseudocysts *a* Traumatic. These may arise from a hæmatoma and are usually large and unilocular.

b Degeneration cysts. These arise from secondary changes in infarcted area. They are usually large and solitary.

Howald, of the Pathological Institute of the University of Geneva, follows this classification as do also most of the recent writers.

It is not our purpose to discuss the minute serous cysts. They are usually discovered at autopsy or accidentally in the course of operations and are not as much of surgical interest as of pathological. It is toward the large solitary cysts of the spleen that we would direct your attention. Of the ninety-one instances of non-parasitic cysts of the spleen which were collected by Fowler in 1921, sixty-five belonged to this group. In a search of the literature we have been able to collect six more such cases and are adding two, one of our own and one of Abell's. We have seen another case in which we made a diagnosis of a splenic cyst, but we have not included it in this report as the diagnosis has not been confirmed by operation.

Pool, in his monograph "Surgery of the Spleen," states that it is the general opinion of surgeons and pathologists that most of the cysts of the

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spleen demanding surgical intervention are hemorrhagic in origin. Our analysis of seventy-three cases of large cysts of the spleen would substantiate his statement in that we found forty-eight, or almost seventy per cent, were blood cysts. Howald states that small cysts are frequently associated with the large solitary cysts and that the small ones may even be microscopic. It is his belief that the blood cysts, so called, are usually due to secondary hemorrhage into a serous cyst, as the study of his two cases revealed that the fluid of the

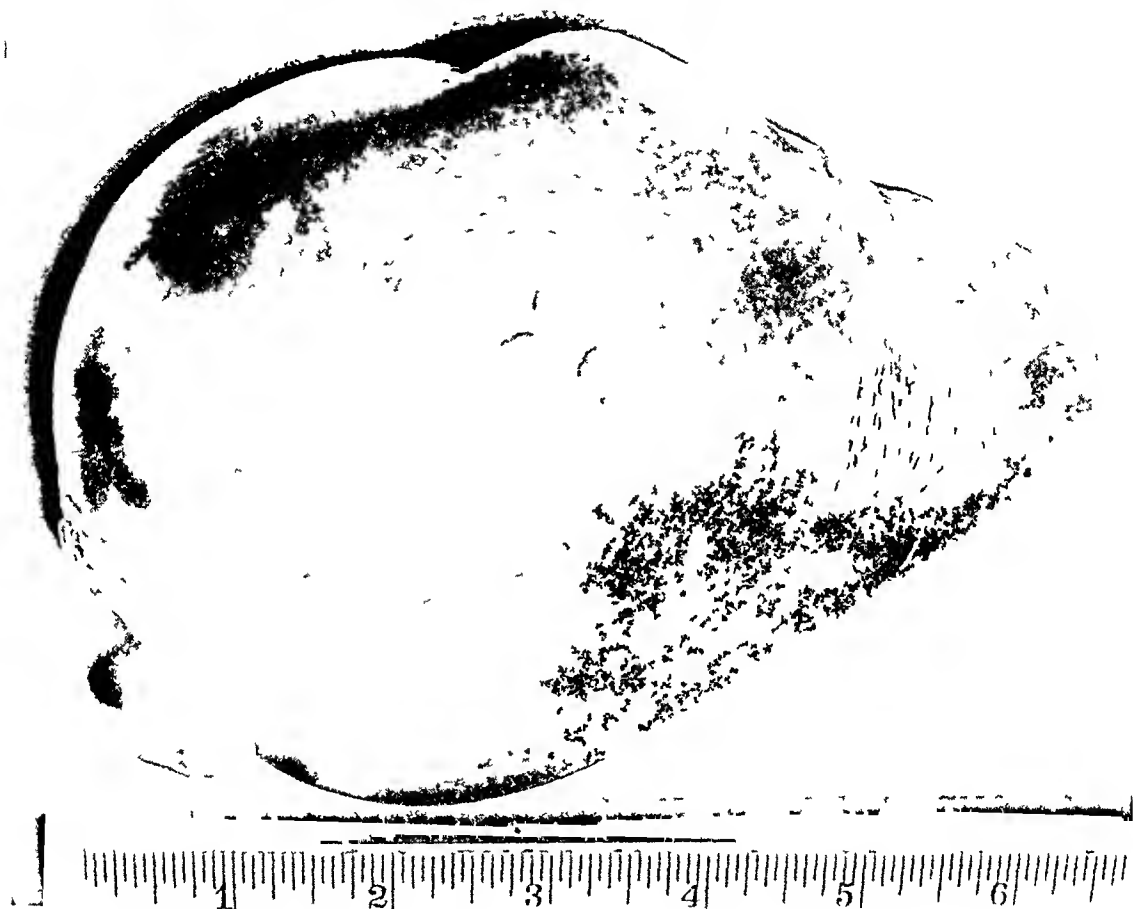


FIG 1—Anterior surface of spleen containing cyst in the lower portion. No break in splenic capsule could be noted.

small cysts was serous in character while that in the large ones was bloody in each case.

All authorities are agreed that trauma plays an important factor in the etiology of splenic cysts. In the seventy-three cases studied by us there was a history of trauma in eighteen. Of these eighteen, only ten were blood cysts so we cannot infer that trauma is the only cause of the hemorrhagic cysts.

Sex, or rather menstruation and pregnancy, may play important etiological rôles. Of the seventy-three reviewed cases forty-seven, or sixty-four per cent, occurred in women. This is in accord with the figures of Hamilton and Boyer, who found sixty-five per cent in females. Of the forty-seven cases occurring in females, twenty-five were between the ages of twenty and forty, and ten occurred in association with pregnancy. Monnier explains the

incidence of occurrence during the reproductive period by the fact that the spleen becomes congested in pregnancy, during menstruation and at the menopause and subsequently relaxes. The content of the cysts which are related to pregnancy is stated in nine cases, only five were blood cysts. This apparently refutes Bircher's explanation for the development of the cyst at this period, as he attributes it to embolism, infarction and hemorrhage following pregnancy. Powers states that aside from the information furnished by



FIG 2—Inferior surface of spleen containing cyst in the lower portion. The tie is small excrescence punctured during removal.

sex and age, the meagreness of the reports makes accuracy impossible. Trauma and antecedent disease of the spleen such as malaria may act as contributory causes in not a few cases. "Regardless of the original cause," says Powers, "we often find recorded an acute exacerbation in the symptoms and aside from childbirth we know nothing of the cause for such exacerbations."

As stated above, previous disease of the spleen may be a predisposing factor in the formation of cysts. In the seventy-three cases which we reviewed, there was a definite history of malaria in twelve, and one occurred during an attack of mumps.

As to the underlying cause of the large cysts of the spleen we are inclined to believe with Howald that all primarily are serous in character. Furthermore, we think that in the beginning they are all small and result from a dilatation of the normal lymph spaces in the organ. In many specimens there is no definite lining wall but a thin smooth membrane, in others there is a definite endothelial lining which is also found even in some of the blood cysts.

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As to the symptoms, these vary with the size of the tumor, and the presence or absence of adhesions. Practically all patients complain of discomfort in the left hypochondrium.

The ideal treatment is splenectomy. In the sixty-five cases which Fowler collected splenectomy was done thirty-three times, and of this number one died and the result in two cases is not stated. Of the eight cases which we have compiled, splenectomy was done in each instance, five recovered and the result is not stated in three. In those cases where adhesions are very dense marsupialization of the sac may be necessary.

As we have stated, Fowler had collected up to 1921, ninety-one cases of non-parasitic cysts of the spleen of which sixty-five may be grouped in the class of large cysts. Since 1921, six additional reports have appeared.

I PRIBRAM, E. E. (*Monatschr. f. Geburtsh. u. Gynak.*, vol. LVII, p. 164) reports two cases.

1. Female, forty, para IV. Pain three months and enlarging abdomen. Tumor in the left side of the abdomen the size of a child's head. Operation disclosed a cyst of the spleen arising in the lower pole and involving the entire organ and could not be separated from it. Splenectomy. Cyst contained serous fluid and the wall was very thin, diagnosis of lymph cyst was made. There was nothing in the history to suggest the etiology and the wall was not studied. The outcome of the operation was not stated.

2. Female, forty-six, para IV. Doctor said spleen was enlarged during the first pregnancy. Swelling in the abdomen for the past year. On the left side was a tumor the size of a child's head below which was a distinctly fluctuating mass. Blood count was normal. Laparotomy revealed an enlarged cystic spleen covered by omentum but freely detached from it. The spleen hung down by the phrenico-lineale and gastro-lineale ligaments and was rotated about these ligaments through an angle of 180 degrees.

The day after operation the white blood count was 30,000 with sixty-seven per cent polymorphonuclears, six per cent lymphocytes, ten per cent mononuclears, five per cent transitionals, and twelve per cent eosinophiles. Fourteen days later the red count was 5,400,000 and the haemoglobin sixty-three per cent, the white blood count was 5200 with seventy-two per cent polymorphonuclears, nine per cent lymphocytes, five per cent mononuclears, three per cent transitionals and eleven per cent eosinophiles.

The spleen weighed 1050 grams, 18 x 12 cm and there was a large solitary cyst containing 575 grams of yellowish-gray thick fluid. Microscopically this showed mostly broken down red cells and cholesterol crystals. The wall was smooth and had attached a few small pieces of calcified material. There was no definite lining to the cyst and the wall was composed of connective tissue. The author states that this may have been a blood cyst.

II GAMBILL, W. L. (*Ky. Med. J.*, vol. XXV, p. 247) reported a case of a serous cyst of the spleen in an Italian woman aged forty-one, para IV. The oldest child was fourteen years and the youngest eight months. Complaint was of pain in the left hypochondrium for four years. Had lost twenty pounds in weight. Operation revealed a cyst at the hilus of the spleen between the layers of the gastro-splenic omentum. Pancreas and omentum were adherent to the growth. The cyst contained one-half gallon of serous fluid which when examined revealed no hooklets nor scolices. Splenectomy was done, patient recovered. (Apparently no study of the cyst wall was made.)

III GOSSELIN, R. I. (*Journ. A. M. A.*, vol. LXVII, p. 849) reported a case of unilocular cyst of the spleen in a woman who had had malaria at the age of seven. The patient was forty-five years of age when seen and the tumor had existed for ten years.

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and had gradually increased in size For seven years previously the patient had been subject to high blood-pressure Laparotomy revealed no twist of the pedicle but many adhesions to the diaphragm Successful splenectomy was done The cyst contained 2000 cc of thin dark brown fluid in which was a large amount of cholesterol and blood pigment The lining wall had a rough and irregular appearance caused by the adherence of some soft friable material which when scraped off left a smooth surface The cyst wall consisted of a thin layer of splenic tissue between the splenic capsule on the outside



FIG 3 —Cyst opened showing smooth lining membrane and trabeculation

and an inner layer of amorphous pink-staining material The main division of the splenic artery was thrombosed though apparently not of recent origin

IV HOWALD, R (Frankfurt Ztschr f Path, vol XXXIII, p 349) reported two cases

1 Hemorrhagic cyst of the spleen removed by Doctor Kummer in 1909, from a patient thirty-eight years old No other details are stated

2 Female, aged twenty-eight, was operated three times in the course of five years for a tumor in the abdomen, and at the third operation a cyst of the spleen, weighing 3500 grams was removed The capacity of the cyst was 2900 cc and the content was hemorrhagic The cyst involved the entire spleen and the wall was composed of splenic tissue In this wall were many small cysts the contents of which were for the most part hemorrhagic The splenic tissue was markedly altered, the follicles being very few and small The inner wall of the cyst had in many places an endothelial lining and beneath these cells was connective tissue poor in nuclei Elastic fibres were only rarely seen Some sections did not show an endothelial lining but a smooth wall Most

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of the small cysts had an endothelial lining beneath which was the connective tissue poor in nuclei

V ABELL, I (Personal communication) operated a woman, aged twenty, para 1, whose complaint was a tumor in the abdomen, discomfort in the left hypochondrium and a smothering sensation on reclining. Patient had malaria at twelve, following which a mass the size of an orange appeared in the left upper abdomen. This mass gradually enlarged but caused no decided discomfort until a year ago. Wassermann was strongly positive. Tumor was not tender and extended from the left costal margin to below the umbilicus and moved with respiration. The blood count was normal except for a slight leucocytosis. Laparotomy revealed a cystic tumor of the spleen which filled the entire left abdomen. The omentum was adherent to the tumor and these adhesions were separated and splenectomy was performed, the patient making a good recovery, although the convalescence was complicated by a purulent pleurisy.

The specimen consisted of a spleen, ovoid in form, $26 \times 19 \times 17$ cm with attached fibrous tags and large tortuous vessels on the surface. At one end there was apparently normal splenic tissue measuring $7 \times 8 \times 2$ cm. When sectioned the mass is found to consist of a single cavity 22



FIG. 4.—Note the dense fibrous tissue wall lined with its single layer of cells resembling mesothelium or endothelium. (Magnification 335 diameters.)

cm in its greatest diameter. The content was pale greenish, grayish-white, thick fluid in which was floating dull grayish-white soft flakey masses. The splenic artery and vein were apparently normal. Examination of the fluid showed a large number of pus cells of which about forty per cent were eosinophiles. The fluid contained albumin and cholesterol and was sterile on culture.

VI The case which we wish to add to those previously mentioned was a negress, aged twenty, who was referred to us on February 24, 1926, by Dr E. C. Wood, of Bloomfield, Ky. She has been married for two years and has had one child and no miscarriages. The family history was entirely negative as was also her past history. She had never had malaria and there was no history of trauma. For about a year she had suffered with a dull ache in the upper left abdomen. Following the birth of her child five months ago she noticed a tumor in the abdomen beginning under the left rib margin and gradually enlarging downward. It was freely movable with change of posture. No gastro-intestinal, cardiac or pulmonary symptoms were present. There were no urinary symptoms and no loss of weight. During the past few weeks she has had pain in the region of the tumor. Menses normal.

Examination revealed a healthy looking, young, colored girl. There was no enlargement of the superficial lymphatic nodes. No enlargement of the thyroid gland was present and the heart and lungs were normal to physical examination. Blood-pressure 120-78.

In the upper left abdomen was a rounded, smooth tumor about eight inches long and six inches wide. Fluctuation was present. No notches could be felt. The tumor was freely movable but could not be pushed into the pelvis. When the patient lies on her right side most of the tumor was to the right of the midline and at about the level of the umbilicus. In this posture percussion over the splenic area revealed the absence of normal splenic dulness. The left kidney could not be palpated.

Except for tenderness in the vaginal vault and a slight cervical laceration, the vaginal examination was negative.

Urinalysis revealed a faint trace of albumin and a large number of pus cells.

The blood count showed eighty per cent hæmoglobin, red blood-cells 4,480,000, white blood-cells 6000, of which forty per cent were polymorphonuclears, fifty-nine per cent lymphocytes and one per cent mononuclears. The Wassermann was negative.

A cystoscopy was done and except for some pus floating in the bladder that organ was normal. A catheter was passed to the left kidney and ten c.c. of fifteen per cent sodium iodide solution was injected. A roentgenogram was then made with the tumor lying in its usual position in the upper abdomen. The tumor was then pushed down toward the pelvis and another plate taken. This revealed a normal renal pelvis in the usual position and that the kidney had not been moved.

Having such data we made a diagnosis of cystic tumor of the spleen. Operation through a left rectus incision revealed a cystic tumor involving the lower half of the spleen. The tumor measured $20 \times 15 \times 12$ cm. Over its lower part were some omental adhesions which were easily separated. The tail of the pancreas was closely associated with the spleen at its hilus. There was no twist of the pedicle. The pedicle was clamped and doubly ligated and the spleen with tumor removed. While manipulating the tumor in its removal one of two small excrescences on the cyst was ruptured and about a pint of greenish fluid escaped. Examination of the abdomen revealed no other pathology and the wound was closed en tier.

The patient made a very uneventful convalescence and the wound was dressed on the fourteenth day, when she left the hospital. Since operation she has apparently had perfect health.

The specimen of splenic cyst was studied by Dr. Stuart Graves of the University of Louisville, who submits the following report. The specimen consists of a large spleen with a cyst measuring approximately $45 \times 130 \times 160$ mm. in its greatest diameter. The cyst has evidently been tapped with a trocar and a good deal of the fluid removed. Capacity of the cyst was 900 c.c. Weight with the cyst content largely removed 353 grams. The cyst occupies a little more than half of the mass. The outer wall is thin and translucent, color varying from pale gray to dark bluish red. Otherwise the surface is smooth and normal. After fixation in Kaiserling fluid the cyst is opened and found to be unilocular, the inner surface being smooth and glistening and marked with interlacing trabeculae. From the solid splenic tissue the cyst is separated by a fibrous wall about 1 mm. in thickness. As elsewhere, this wall is thin and translucent, smooth and glistening on the inside and intimately connected with splenic tissue on the outside. The cut surface of the splenic tissue itself shows cross-sections of trabeculae relatively numerous, otherwise the cross-section is not abnormal.

The microscopic examination of sections of the solid portion of the spleen and of the wall of the cyst show the latter to consist of dense fibrous tissue, lined with a single thin layer of cells. These cells have ovoid nuclei, are rather pale, and are fairly close together. In the solid portion of the spleen the trabeculae are relatively numerous and close together. The lymph follicles are small and relatively more numerous and closer together than normal, indicating compressed splenic tissue.

Bacteriological examination of the fluid removed from the cyst show all smears and cultures both aerobic and anaerobic, negative for growth after five days.

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Physical and chemical examination of the fluid shows it to be slightly turbid, pale greenish in color, and about the consistency of ascitic fluid. The specific gravity is 1.016. Microscopic examination of the centrifuged sediment shows some flat crystals, evidently cholesterol, and moderately numerous endothelial leucocytes filled with vacuoles which stain red with Scharlach R. The chemical examination shows no chlorides, sulphates, phosphates or bile. Traces of blood and cholesterol are present. The albuminous material is approximately seven per cent. The reaction is alkaline.

Reference to the gross and microscopic description in this case shows conclusively that this cyst is non-parasitic. Its size, its single chamber, its lining and the physical and chemical examination of its fluid would indicate that it may have begun either as an infoliation or a dilatation cyst and then gradually enlarged to the size recorded. This size must have been gradually attained over a considerable period of time because the wall was strong and well formed and the contents were practically negative for any blood constituents. The lining cells appear more like mesothelial and endothelial cells, which also adds evidence in favor of an infoliation or dilatation cyst.

TRAUMATIC ABSCESS OF THE SPLEEN*

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UNDER traumatic abscess of the spleen I shall consider those collections of pus, splenic and perisplenic, in the left subdiaphragmatic region, resulting from secondary infection and suppuration of a contused spleen or of a hæmatoma arising from injury to splenic tissue. Such traumatic abscesses of the spleen are rare. In a search of the available literature I have been able to collect only twenty-three cases exclusive of one of my own herewith reported. The first of these was described by Henning in 1757. Doubtless, however, the condition is more common than this small number would indicate. These abscesses constitute about 15 per cent of the total number of abscesses of the spleen (Kuttner, Scheyer). They are much less common than those having as a basis either metastatic inflammation or infarcts occurring in the course of septic diseases, typhoid fever, recurrent fever, malaria, dysentery, and influenza, which together constitute about 75 per cent of the cases. The third group of splenic abscesses, that of suppurations caused by extension from neighboring organs, chiefly from carcinoma and ulcer of the stomach, is still more rare than the traumatic. The group here under consideration differs sufficiently from the ordinary splenic abscess, not only in its etiology, but also in its clinical picture and prognosis, to justify its separate presentation.

Pathogenesis—The spleen, soft and vascular, offers but little resistance to injury, yet, due to its small size and protected situation under the ribs, damage to it is infrequent. Even more easily traumatized is the diseased spleen, since the hypertrophied organ not only offers a less resistant tissue, but also a greater surface to be injured, coming partially out from protection under the rib margin.

Any injury to the left side of the body may be associated with damage to the spleen. When the left lower part of the chest is forcibly struck and ribs are fractured, or when the enlarged organ is struck in the left hypochondrium, damage to the spleen is especially probable. The methods of injury are varied: falls, direct blows with fist or cane, being run over by vehicles, gunshot wounds, horse kicks, anything whereby direct violence is applied to the splenic region. Further, such apparently trivial acts as sneezing or heavy lifting may tear the diseased spleen. When the spleen is injured it either ruptures or is contused. When it ruptures and the larger blood-vessels are torn, death may occur from profuse hemorrhage or be averted only by the timely removal of the spleen. Rupture of the spleen, however, may be minor, and the symptoms not those of a major abdominal catastrophe,

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indeed symptoms pointing to the spleen may be completely masked by the associated injuries which are more patent, such as fracture of the ribs or limbs, and injuries to the head with coma. In such instances the bleeding may not be great, the hemorrhage is spontaneously arrested and a perisplenic hæmatoma forms. Portions of the splenic tissue itself may be so contused that they are no longer viable and may come to form part of the subdiaphragmatic collection. When the injury sustained is less severe contusion alone occurs. In this event the tissue is injured without solution of continuity, small extravasations of blood and subcapsular hæmatomas may occur, but the capsule itself is intact. After a slight injury the tissue recovers if the extravasated blood is gradually absorbed, there then remains only a scar in the splenic tissue as a sign of the injury. However, the extravasated blood is not always absorbed. Frequently it becomes encapsulated and forms a cyst. Such a cyst may remain dormant for years only later, frequently after a fresh trauma, to grow and become of clinical significance.

More rarely and instead of the formation of a cyst, infection of the collection of extravasated blood may occur. It is this contingency that demands that contusions of the spleen be taken seriously because of the conditions which can follow such an injury rather than because of the immediate surgical indications. Although there exists in the spleen less opportunity for infection than, for instance, in the liver with the presence of bile and the bacterial content of the portal blood, or in the kidney with its connection with the bladder, yet such infection occurs. The pyogenic organisms can come only through the arterial blood stream or by extension from a neighboring focus. When such infection occurs, the hæmatoma, splenic or perisplenic, suppurates and there develops a traumatic abscess of the spleen in the sense defined in this paper.

Such a splenic abscess may not contain pus alone, often it contains also free pieces of necrotic splenic tissue of varying size. Indeed, the entire spleen may be composed of a sequestrum. It is to such abscesses that Kuttner has given the name "sequestrating abscess of the spleen." Such sequestria are not limited to the cases of traumatic abscess but also occur as a result of infarction in the other groups of splenic abscess. About 37 per cent of all splenic abscesses are of this type. If the contusion to splenic tissue is great, the contused area goes on to necrosis. The secondary suppuration separates the necrotic portion and leaves it as a sequestrum. It is possible also that several areas of contusion may suppurate and the intervening tissue necrose from interference with its nutrition. In the few instances where the entire splenic parenchyma has been loosened from its capsule, there was formed probably a subcapsular hæmatoma which spread out under the whole capsule. Generally, however, the splenic capsule does not hold and rupture occurs. Kuttner was able to produce experimentally in rabbits the sequestrating type of abscess by first contusing the spleen and then injecting staphylococci into the blood stream. In two only of the cases of traumatic abscess collected here were any bacteriologic studies of the pus made. In the

case of Weichert streptococcus pyogenes was found, in that of Omí the pus was sterile. It is probable that the ordinary pyogenic organisms are responsible, and that the pus is sometimes sterile in latent cases of long duration. The source of the infecting organisms is not always evident. In the case of Lampe it was a felon, in that of Trapp furunculosis, in that of Weichert an infected compound fracture-dislocation at the wrist. It seems reasonable that the splenic flexure of the colon, as the result of slight associated trauma, might permit the passage of organisms to the splenic area. The pus obtained has been described frequently as foul-smelling such as occurs in infections due to the colon bacillus.

Symptoms and Course—Traumatic abscesses of the spleen run a fairly typical course which differs only in certain respects from that of abscesses of the spleen of different etiology. For purposes of ease of clinical description, I have divided this course into three stages: (a) stage of initial injury, (b) intermediate or cryptic stage, (c) terminal stage, or stage of extension or rupture. Similarly I have divided the cases into four groups which differ somewhat not only in the picture presented, but also in the ease of recognition and in prognosis. Group 1, in which the injury was more or less limited to the splenic area, Group 2, in which the injury to the splenic area was associated with other injuries, Group 3, in which the injury caused symptoms indicating early operation, and Group 4, in which the cases were all latent.

Group 1—The cases in this group are the most typical and occur the most frequently. In the initial stage the patient receives an injury from blunt force, either to the left hypochondrium or to the left lower part of the chest wall. There is immediate pain and tenderness in the contused area which may be transient or persistent. The pain may be increased by deep breathing. Within a few hours slight enlargement of the spleen may be noted on palpation and percussion, if the injury is limited to the upper pole little change may be demonstrable. Shock and signs of marked hemorrhage are absent, yet there may be symptoms of peritoneal irritation with initial vomiting. The symptoms soon tend to subside and it is believed that the patient will rapidly recover. This marks the beginning of the intermediate stage. There may be a period of almost complete freedom from symptoms, or the patient may complain of only slight persistent pain or heaviness in the splenic region, in intrasplenic collections of pus pain may not be felt for a long time. Soon, however, there develops a cryptic fever which may gradually increase in the height of its afternoon rise. There may be chills. Often there are night-sweats. The patient is weak and has anorexia. Splenic enlargement may increase, or may appear for the first time, taking the form of a mass in the left hypochondrium or of a bulging of the left lower thorax with edema in the overlying skin. Fluctuation will occur only when as the result of adhesion to the abdominal wall the abscess comes close under the abdominal parietes. In the terminal stage the abscess develops complications if it is not evacuated operatively. The pleura is most frequently involved. This occurs chiefly in abscess of the upper pole. Pleural effusion occurs which

may be repeatedly aspirated, or it becomes purulent and forms empyema. If the abscess is not evacuated by operation it ruptures. This occurs, in order of frequency, into the stomach with vomiting of pus, into the peritoneum with peritonitis and death, into the colon with passage of pus in the stool, through the chest wall with fluctuant elevation of the skin, into the renal pelvis with pyuria, or into the pleural cavity. The direction of rupture depends largely on the location of the abscess, chiefly toward the stomach if it is in the upper pole, or toward the peritoneum if it is in the lower pole. Even if the abscess has been incised and drained perforation may occur. Cases in this group run their course in from two weeks to four months, in an average of two to three months.

Group 2—In this group the traumatic force is greater and more widely distributed, and there are also other injuries. The initial stage is much more severe. The patient may be unconscious. Shock and profuse hemorrhage are frequent. The more patent, and for the time being more important, injuries, such as compound fracture of the extremities, and trauma of the chest with hæmoptysis, distract attention from the splenic area so that damage there is easily overlooked. Not until the intermediate stage when the patient is recovering from the injuries for which he is being treated may it dawn upon the surgical attendant that all is not well. The patient still remains ill, the hectic fever seems inexplicable, and it is only at the terminal stage when complications occur that the true nature of the events, as determined by operation or necropsy, is realized. My own case belongs in this group.

Group 3—In this group the initial symptoms are those of rupture of the spleen. The patient suffers a major abdominal catastrophe as the result of the injury. Signs of hemorrhage and shock are present, and the abdomen is tender and rigid. Operation is performed, blood evacuated from the abdomen, and tamponade or removal of the ruptured spleen performed. Following this the patient who is apparently recovering develops symptoms of infection in the left subdiaphragmatic space. These progress until death or a subsequent operation for evacuation of an abscess which has formed in an unremoved blood clot or in the remaining contused splenic parenchyma.

Group 4—This group differs from Group 1 only in the time interval and in the latency of the symptoms in the intermediate stage. The patient recovers from the injury and is apparently symptomless, or at most suffers from a vague indisposition, for from one to several years. Cachexia is frequent. Distress may occur in the left hypochondrium. A mass, often fluctuant and reaching large proportions, is usual at the left costal margin. In the terminal stage either a large amount of pus is evacuated at operation, or the abscess empties itself by perforation with the patient experiencing the sensation of something rupturing or tearing inside him.

Diagnosis—Diagnosis may or may not be difficult. In Group 1 attention is at once centred on the spleen as the seat of possible injury, and when persistent fever develops an abscess is at once thought of. In Group 3 the state of affairs is largely self-evident. However, in Group 2 the condition is

obscured and may be entirely overlooked. In Group 4 the long time intervening between the initial stage and the stage of marked clinical symptoms may cause both patient and examiner to suspect no connection between the large splenic tumor and the injury sustained. Bogdanik elicited a history of injury in his case only after operation.

Exploitory puncture through the chest wall with aspiration is a procedure that cannot often be dispensed with in establishing a diagnosis, especially of abscess of the upper pole. It is not without danger. In case of positive findings operation should follow immediately in order to avoid spreading the infection along the tract explored by the needle into an uninvolved pleural cavity. Examination by means of the Rontgen-ray has seldom been employed since many of the cases occurred before the advent of roentgenology. Such examination may be negative, or at most may show a high-lying, fixed diaphragm on the left. In Scheyer's patient an air bubble was seen beneath the diaphragm. The finding at operation of necrotic masses in chocolate-colored pus points to the spleen as the seat of origin in all subphrenic abscesses on the left side. Remains of the trabecular system seen on microscopic examination of the necrotic tissue identify it as splenic.

Treatment—The treatment is surgical. The abscess must be adequately incised and free drainage established. Two chief routes of approach are available. In abscess of the upper pole the peripleural transdiaphragmatic route with rib resection is indicated. In abscess of the lower pole with encroachment on the peritoneal cavity, laparotomy, either at the rib margin or through a left rectus incision, may be preferable. Lumbar incision is seldom indicated. The operation of choice is splenotomy with tamponade. When the whole spleen exists as a sequestrum it should be removed. In cases in Group 3 splenectomy is indicated at the primary operation, if the splenic region cannot be freed completely of blood and damaged tissue, or if subsequent oozing of blood is probable, drainage should be provided. Circumstances will determine whether operation should be performed in one or in two stages. With care infection of the pleural or of the peritoneal cavity may be avoided in most instances, if so, the entire procedure is carried out in one stage. In the cases reported in this paper approach has been chiefly through the chest wall with resection of the tenth rib. Bogdanik sewed the spleen to the abdominal wall.

Prognosis—The prognosis is grave. In this series of twenty-four cases there were fourteen deaths, a mortality of 58 per cent. The prognosis is worst in Groups 1 and 2, and best in the latent cases of Group 4. Thirteen patients were operated on with five deaths, a mortality of 38 per cent. Among the eleven others there were nine deaths, or a mortality of 82 per cent. Recovery occurred in two latent cases, following rupture into the stomach and renal pelvis in one instance and into the stomach and colon in the other. Thus death occurred in all the medical cases in this series except the latent ones. With more frequent correct early diagnosis and timely surgical intervention doubtless these results will be improved.

TRAUMATIC ABSCESS OF THE SPLEEN

REPORT OF A CASE

A man, aged nineteen, was admitted to the W S Major Hospital, July 13, 1924, at 10 00 P M, with a diagnosis of compound fracture of the humerus. At 3 00 P M, while riding a bicycle he had been struck by an automobile. He was knocked high into the air and alighted on his left side, with his left arm twisted beneath him. He was unconscious for a short time and lost about a pint of blood. On being taken to the office of a country physician for first aid he fainted, and again on admission to the hospital. He complained chiefly of the injury to his left arm, but stated also that he was extremely sore throughout his left side, especially in the left abdominal, lumbar, and anterior-chest regions.

Examination revealed that the patient was badly injured, pale, and faint. There was a compound fracture of the left humerus in the middle third with marked laceration of the skin. He was unable to extend the fingers of the left hand or the hand itself. The left radial pulse was not palpable. Nothing abnormal could be detected in the heart or lungs. He was tender to pressure throughout the left anterior part of the chest and the whole left side of the abdomen. The abdominal wall was not rigid, and no free fluid could be demonstrated in the abdominal cavity. A catheterized specimen of urine showed no blood, but contained albumin and also many casts. The hæmoglobin



FIG 1 —Ruptured spleen

was 75 per cent, the temperature 98°, the pulse rate 78, and the respiratory rate, 30.

An hour later the lacerated tissues of the arm were excised under anæsthesia and a large hæmatoma was evacuated. There was much venous bleeding which was controlled by packing with iodoform gauze. The arm was put up temporarily with a triangular axillary pad and external splint and strapped to the body.

The next morning the patient complained of pain inside the left side of the chest, coughed up a little blood-streaked sputum, suddenly became dyspnoeic with a respiratory rate of 40, and pulse rate of 140, sweat profusely and appeared in shock. The blood pressure, however, was 110 systolic and 60 diastolic. It was difficult to examine the chest posteriorly, but partial examination disclosed nothing save tenderness to pressure. Voiding was impossible until the following day, when he was much improved, the pulse rate had dropped to 110. Two days later the arm was put up in suspension from a Balkan frame and traction applied to the elbow. The wound was at first irrigated with Dakin's and later with physiologic sodium chloride solution. The temperature was 100°, the pulse rate 100, and the respiration rate 30. Albumin and casts had disappeared from the urine.

Following this, save for an occasional involuntary stool, the patient seemed to be in good condition and had little complaint. However, he began to run a persistent septic

SYNOPSIS OF REPORTED CASES OF TRAUMATIC ABSCESS OF SPLEEN
Group I Injury More or Less Limited to Splenic Area

Case No	Injury	Chief clinical data	Operation	Necropsy	Result
1 Fahner (Mayer)	Fell from ladder striking left side	Young man Immediate and persistent pain Later cryptic fever and night sweats Fluctuant elevation injured area Symptomless for 2 mos post-operative when suddenly vomited large amount of pus and died	Incision with evacuation of 12 ounces foul smelling pus	Spleen three times normal size, adherent to stomach, cartilaginous in consistency Abscess cavity in spleen opening into stomach	Death in two mos plus
2 Gockelhus (Mayer)	Struck in left hypochondrium by iron knob of walking stick	Baker Marked pain area of injury Anorexia Finally developed a swelling of abdomen similar to an ascites		Large and deep slough in spleen corresponding to size of head of cane Large amount of foul smelling material in peritoneal cavity	Death
3 Jacquinelte (Mayer)	Fall	Pain left hypochondrium Before death dark foul smelling pus evacuated with stool		Spleen enlarged, adherent to colon, containing abscess communicating with gut	Death
4 Sanger (Tillmans)	Fainted and fell in room striking left side	Cook 26 yrs old Ill 35 days		Contusion of spleen with perisplenic abscess Perforation into pleura, terminal perforation into stomach and duodenum	Death in 4½ mos
5 Otis (Kuttner)	Left side struck by rolling cannon ball	Soldier Able to wander several miles after injury Increasing swelling of abdomen		Large abscess cavity diaphragm to iliac region Perforation of diaphragm Spleen in two pieces, contused, floating in abscess	Death in 43 days
6 Jaffel (Kuttner)	Run over by vehicle	Coachman 24 yrs old Splenic enlargement with tenderness After 8 days pain, fever, left-sided pleuritis Two aspirations of subphrenic abscess—3,000 c c brown fluid Generalized peritonitis		Diffuse peritonitis, 500 c c serous exudate left pleural cavity Abscess cavity limited by diaphragm, colon, and abdominal wall Spleen contused swollen, oft in upper part of cavity	Death in 13 days

TRAUMATIC ABSCESS OF THE SPLEEN

No.	Name	History	Physical	Pathology	Treatment	Outcome	Recovery?
7	Lampe (Trapp)	Lifted heavy object	Male 30 yrs old Panarium short time before Stabbing pain splenic region Later serous and purulent exudate removed from left pleural cavity Convalence prolonged after operation	Resection 9th rib Serous pleural exudate evacuated Diaphragm bulged by subphrenic collection Resection 11th rib Pus containing many pieces of splenic tissue	Gangrenous areas 1 lobe of lung Abscess splenic area, small portions of spleen still present Terminal perforation into stomach	Death in 3 mos, 2 mos post-operative	
8	Scheyer	Struck in left side by wagon tongue	Blacksmith 60 yrs old Chronic endocarditis and several previous chest infections Gradual decline after injury Cachectic weak, pain left chest Aspiration small amount foul smelling fluid X-ray—high diaphragm with air bubble	Resection 10th rib Abscess cavity size of two fists containing stinking pus Free pieces of necrotic spleen	Perforation with acute peritonitis Diffuse splenic necrosis with secondary suppuration	Death in 3 mos	
9	Anis (Scheyer)	Blow of fist against left lower ribs	Male Malarial spleen Within a month development of large perisplenic abscess	Laparotomy with evacuation of pus In abscess cavity large free splenic sequestrum			Recovery?
10	Vulpius (Scheyer)	Mishandled by husband—left abdomen stepped on	Female 42 yrs old Transient pain left hypochondrium	Incision into abscess cavity from which the larger portion of the spleen, necrotic, was removed 5 wks later			Recovery
11	Silberstein (Edler)	Severe sneezing to blowing grippe	Previous splenic tumor present Immediate pain in left hypochondrium, fever, and gradual development of swelling and prominence left chest wall Questionable case—abscess may have been secondary to grippe and sneezing of no moment	Incision region of 10th rib with evacuation of large amount of pus			
Group II Injury Splenic Region Associated With Other Injuries							
12	Göhde (Mayer)	Gunshot wound	Soldier Fracture of left radius Superior tunneling of left side of body with fracture of 12th rib Forty-seven days later anorexia, fever, tenderness splenic region Six days later sudden symptoms of diffuse peritonitis	12th Rib and radius healed with solid callus Erosion outer surfaces spleen, several abscesses in substance of organ One abscess perforated into peritoneum Peritonitis		Death in 54 days	
13	Trapp	Knocked off by wagon limb of tree Run over	Unconscious 5-6 hrs Contusion! temporal region R hemothorax, possible rib fracture Developed icterus from possible rupture of liver, then a severe general furunculosis Persistent fever 52nd day aspiration of 1 pleural effusion 2 wks later 2nd aspiration—pus with streptococci Gradual decline following operation	Sixty-seventh day resection of 10th rib Incision into abscess cavity size of two fists filled with pus and necrotic tissue Drainage	Abscess cavity between spleen and diaphragm walled-off from abdominal cavity by adhesions Necrotic splenic tissue in abscess Larger portion of spleen, however, intact	Death in 4½ mos	

SYNOPSIS OF REPORTED CASES OF TRAUMATIC ABSCESS OF SPLEEN
Group II Injury Splenic Region Associated With Other Injuries—Continued

Case No	Injury	Chief clinical data	Operation	Necropsy	Result	
					Recovery	Recovery
14 Karewski (Kuttner)	Caught between wagon and side of gateway	Maiden 12 yrs old Unconscious Awoke with vomiting and in severe shock Fracture rt clavicle Symptoms of diffuse peritonitis After 14 days seemed well Became ill again with fever Dullness lower thorax with resistance pus margin Aspiration—foul smelling pus Shock Fracture 6th and 7th ribs on left Pain cardiac region Next day dullness left abdomen to axilla Eleventh day severe pain in abdomen, dyspnoea, tenderness rise in temperature, tenderness and dullness under xiphoid	Resection 10th rib Diaphragm bulged against costal pleura Incision with evacuation of pus Spleen present as complete sequestrum, removed without bleeding Resection lower two ribs Cavity size of child's head filled with coagulated blood In middle of cavity lay the spleen twice normal size with the capsule torn from its places Spleen torn from its pedicle without bleeding		Recovery	Death in 14 days Rupture of splenic capsule with escape of blood into peritoneal cavity Purulent peritonitis Streptococcus pyogenes in pus from peritoneum and from arm
15 Pflucker-Bardenhauer (Kuttner)	Fell 4 meters into cellar	Abrasions left side Right hand luxated, ulna protruding, radius fractured Infection of wound, resection of ends of bones with packing Gradually localized pains splenic region with flatness Blood culture neg Sudden peritonitis				Death in 3 wks
16 Weichert	Fell 12 meters from roof					
<i>Group III Injury With Symptoms Indicating Early Operation</i>						
17 (Berger)	Run over by vehicle	Young man Symptoms of peritonitic involvement Laparotomy Much blood in abdomen from a ruptured spleen Splenectomy Development of a subphrenic abscess	Resection of 10th rib on 13th day Drainage of subphrenic abscess Incision of abscess in abdominal wound			Recovery?
18 [Kriekow (Berger)]	Beaten by husband	Female 31 yrs old Peritonitis and ascites Laparotomy after 42 hrs Evacuation of much blood, tamponade of rupture of spleen Removal of diseased uterus adnexa Seven days later opening of pelvic abscess per vagina				

TRAUMATIC ABSCESS OF THE SPLEEN

Recovery in
2½ mos

Resection of 10th rib 10 days later
Evacuation of sub-diaphragmatic abscess Four subsequent aspirations of effusion in left chest

Operation in 3 hrs Wound enlarged Left pleura and diaphragm shot through Closure Laparotomy Evacuation of much blood Spleen shot through Tamponade

Shot in 6th intercostal space

19 Krjenkowi (Berger)

Group IV Latent Cases

Recovery

Recovery

Death in 1 yr 4 mos

Recovery

Young woman Cachectic After several years ill without preceding incident Pain in splenic region, no tumor palpable Unable to walk or sit, or to breathe deeply when straightened out Sudden sensation of something tearing inside Vomiting of pus, likewise large amount of pus in urine for several days

Maiden 19 yrs old Marked pain which disappeared in 12 days No further symptoms save heavy feeling in splenic region at menses and on marked bodily movement After three years sudden rupture and emptying of abscess by vomiting and diarrhoea

Male, 27 yrs Had had malaria 7 yrs Pain and swelling after injury A year later cachectic, upper abdomen bulging, tenderness and questionable fluctuation left hypochondrium Smooth convalescence post-operative for 4 mos when following a dietetic indiscretion died of peritonitis from perforation of small remaining pus focus

A year later pain left chest and abdomen Abdomen distended and tense Tender round body palpable which extended from right mammary to left axillary line

Fall injuring left side

Skating striking left hypochondrium on stone

Blow of fist left costal margin

Blow on left side

20 Henning (Mayer)

21 Kerkring (Mayer)

22 Omi

23 Bogdanik

temperature, ranging from 99° to 101° in the mornings, and from 101° to 103° in the afternoons, the average temperature range being from about 100° in the morning to 102° in the afternoon. The amount of infection in the area of the fracture seemed insufficient to explain the temperature course. No abnormal findings could be made out in chest or abdomen. The leukocyte count was not high, running persistently about 10,000.

On the afternoon of the eighteenth day he experienced pain in the anterior left side of the chest and felt that the precordial region had "filled up" so that he could scarcely get his breath. He was very dyspnoeic and had a few attacks of coughing with the expectoration of a frothy non-purulent sputum streaked with blood. On examination there was little respiratory excursion of the left chest, the anterior portion of which was hyperresonant. The next morning the hyperresonance was still noted and it was difficult to outline the cardiac dullness. The posterior left part of the chest was now almost flat to percussion up to the interscapular region, and the breath sounds at the base of the lung were diminished. Thoracentesis in two different areas was ineffectual. The following day he complained of pain on the right, running from the right half of the neck obliquely through the right side of the chest to its base. He felt better and could breathe better lying on his right side. He was dyspnoeic, coughed up bloody sputum and had the appearance of a patient with pneumonia. There were now indications of consolidation of the right lower lobe posteriorly with a pleural friction rub. The leukocyte count was 22,000. Death occurred the next morning, three weeks after injury.

Necropsy.—At post-mortem examination there were about 100 c.c. of serosanguinous fluid in the peritoneal cavity and adhesions in the left hypochondrium involving the whole of the spleen, the cardia, lateral and posterior upper left abdominal wall, and the left diaphragm. The spleen was severely contused and friable in its upper pole anteriorly with a fissure running from the anterior border at the middle to the hilus (Fig 1). It weighed 195 gms. Between the spleen and the diaphragm there was a small abscess with a definite abscess wall, containing about 30 c.c. of pus and old blood together with several small pieces of necrotic tissue. There were adhesions in the pelvis with matting together of loops of the small intestine. The anterior mediastinal tissues were emphysematous and oedematous. About 200 c.c. of serosanguineous fluid with flakes of fibrin were found in the right pleural cavity. The right lower lobe itself was semisolid and its pleural surface covered with fibrinous exudate. There were about 200 c.c. of fluid, not so bloody as that on the right, in the left pleural cavity. From the region of the sixth rib in the midaxillary line the diaphragm was adherent to the chest wall, the sixth rib was fractured. The left lower lobe of the lung was solid and resembled hepatic tissue on cross-section. The wound of the left arm was clean. There was complete mobility at the area of fracture with little formation of callus.

SUMMARY

Traumatic abscess of the spleen is rare, but twenty-three cases being found in the available literature. These and a personal case are reported. The condition is the result of injury to the splenic region with contusion or rupture of the spleen. Secondary infection of hæmatomas and contused tissues leads to the formation of abscess. Separation of necrotic masses often gives splenic sequestra.

The course may be conveniently divided into three stages: (1) stage of initial injury, (2) intermediate or cryptic stage, (3) terminal stage or stage of extension or rupture.

The cases fall into four groups: (1) in which injury is more or less limited to the splenic area, (2) in which injury to the splenic area is asso-

TRAUMATIC ABSCESS OF THE SPLEEN

ciated with other injuries, (3) in which injury is associated with symptoms indicating early operation, and (4) in which the cases are latent

Diagnosis may be difficult Many cases have been recognized only following rupture or at operation or necropsy The treatment is surgical The prognosis is grave The mortality has been 58 per cent The morathly of patients operated on was 38 per cent, of medical patients (excluding latent cases) 100 per cent

Earlier diagnosis with timely intervention should improve these results

BIBLIOGRAPHY

- ¹Berger, Erich Die Verletzungen der Milz und ihre chirurgische Behandlung Arch f klin Chir, 1902, vol lxxviii, pp 768-816, 865-914
- ²Bessel-Hagen, F Ein Beitrag zur Milzchirurgie Arch f klin Chir, 1900, vol lxi, pp 188-231
- ³Bogdanik, J Traumatischer Milzabszess Berl klin therap Wchnschr, 1905, vol ii, pp 7-9
- ⁴Edler, L Die traumatischen Verletzungen der parenchymatosen Unterleibsorgane Arch f klin Chir, 1887, vol xxxiv, pp 573-620
- ⁵Elting, A W Abscess of the Spleen ANNALS OF SURGERY, 1915, vol lxi, pp 182-192
- ⁶Grand-Moursel, P E Contribution a l'etude des abces de la rate Paris, Thesis, 1885, 47 pp
- ⁷Kuttner, Hermann Ueber sequestrierende Milzabzesse Beitr z klin Chir, 1907, vol liv, pp 405-457
- ⁸Lenormant, C, and Seneque, J Les abces de la rate Jour d chir, 1923, vol xxi, pp 685-698
- ⁹Mayer, Ludwig Die Wunden der Milz Leipzig, F C W Vogel, 1878
- ¹⁰Omi, K Ueber traumatische Milznekrone mit perisplenitischen Abszess Beitr z klin Chir, 1906, vol li, pp 359-367
- ¹¹Scheyer, K Ueber sequestrierenden Milzabszess Beitr z klin Chir, 1924, vol cxlxi, pp 225-241
- ¹²Tedenat Abces de la rate Rev d Gynec et de Chir Abdom, 1901, vol v, pp 622-632
- ¹³Tillmann, H Ueber die Communicationen des Magen-Darmcanales mit der Brusthohle und uber subphrenische Kothabszesse Arch f klin Chir, 1881, vol xxvii, pp 103-161
- ¹⁴Trapp Zur Kenntniss der Verletzung der Unterleibsorgane (Zwerchfell, Milz, Leber) durch stumpfe Gewalt Deutsch Ztschr f Chir, 1897, vol xlv, pp 393-408
- ¹⁵Weichert Vereiterung eines Milzhamatoms nach infizierter komplizierter Vorderarm fraktur Berl klin Wchnschr, 1911, vol xlviii, pp 1157-1158
- ¹⁶Wildegans Zur Pathologie und Therapie des Milzabszesses Arch f klin Chir, 1920, vol cxiv, pp 416-442

DUODENITIS *

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THE problem of peptic ulcer has not been solved. Although the diagnosis of this type of ulcer can be made with a high degree of accuracy, the treatment is not as yet on a uniform and absolutely sound basis. In spite of many theories, the origin of peptic ulcer remains unknown. Our knowledge of the pathology of duodenal ulcer has been advanced in recent years by the study of tissues removed at operation, such study has demonstrated the occurrence of an inflammatory lesion which we call duodenitis. The term duodenitis has been more or less arbitrarily limited to a type of chronic



FIG 1 —Gross appearance of true duodenal ulcer

inflammation of the duodenum without calloused ulcers, the clinical picture of which is practically identical with that of chronic duodenal ulcer. The cause of the disease is unknown. The pathologic findings are distinctive. The association between duodenitis and chronic ulcer of the duodenum is probably close, but the exact relationship of the two lesions is not known. Gastritis and jejunitis are pathological and surgical entities and probably bear the same relationship

to gastric ulcer and jejunal ulcer as duodenitis does to duodenal ulcer.

W J Mayo was among the first to recognize that duodenal ulcer exists in two forms, the indurated calloused ulcer which can be seen and felt from the serosal surface, and the non-indurated ulcer which cannot be seen from the outside, cannot be palpated, and is, indeed, recognized with difficulty even with the intestine open, since its site is sometimes marked by only a minute abrasion of the mucosa. This is the so-called clinical ulcer, to which the early failures in the surgical treatment of peptic ulcer were largely attributed.

Some years ago, we called attention to two distinct pathologic lesions in the duodenum, either of which may occur when there is a characteristic history of chronic peptic ulcer. The first is the true ulcer, which is recognized by the congestion and stippling of the serosal surface with more or less scar tissue, and adhesions and deformity of the duodenum. The wall of the

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bowel is always indurated and a tumor may form as a result of the defensive reaction of the surrounding tissues, if the ulcer has perforated the bowel slowly. When the intestine is open a crater ulcer is seen (Figs 1 and 2). The second type of lesion, which we have called duodenitis or submucous ulcer, is characterized by congestion and stippling of the serosa with little or no induration. Palpation of the duodenum is negative and when the bowel is opened no lesion of the mucosa can be found, or at most, only one or more small superficial mucosal abrasions (Figs 3 and 4). These might be considered healed ulcers were it not that the congestion, oedema, stippling, and the presence of symptoms constitute evidence of a pathologic process going on in the wall of the intestine. Microscopic examination reveals little or no abrasion of the mucosa, but the submucosa, and sometimes the muscle layers, are infiltrated with lymphocytes. Often there is a tendency to circular constriction of the bowel, but it is difficult to determine whether this is due to spasm or true narrowing. Clinically there is little if any difference between the two types. The roentgenogram shows spasmodic deformity in

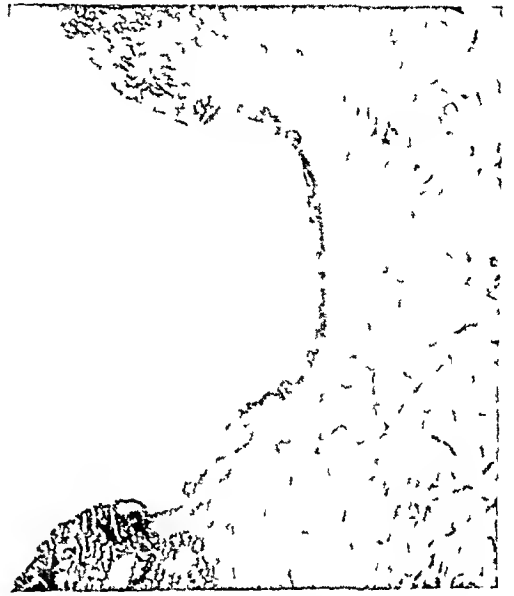


FIG 2 — True duodenal ulcer showing crater (x9)



FIG 3 — Gross appearance of duodenitis

both lesions. That duodenitis is not a stage from which true ulceration invariably develops is shown by the fact that the average duration of symptoms of the two lesions is about the same. The terminology has no bearing on the clinical diagnosis or treatment.

MacCarty has reviewed ninety-seven excised, localized, inflammatory duodenal areas and has found that the pathologic picture of duodenitis is cellular destruction with congestion, oedema and migration of polymorphonuclear leucocytes, lymphocytes, and endothelial leucocytes. The lesion may be localized or diffuse.

The recently advocated treatment of duodenal ulcer by extensive resection of the first portion of the duodenum and pyloric portion of the stomach has led to interesting pathologic findings. Konjetzny, Orator, Puhl and others note that in nearly all cases of gastric and duodenal ulcer there is more or less extensive gastritis and duodenitis.

Konjetzny observed it in twenty-two cases of duodenal ulcer. Grossly there are wart-like papillary outgrowths of epithelium together with thinned-out atrophic areas. All stages of superficial ulceration are seen, from tiny abrasions to fissures and ulcers of appreciable size. These lesions are covered with fibrinous



FIG 4—Duodenitis showing the intact mucosa (x50)

exudate. Microscopically, inflammatory changes are seen in the mucosa which is oedematous and infiltrated with polymorphonuclear leucocytes and lymphocytes. The epithelium is denuded in places and in others it has regenerated. In areas where the epithelium is denuded, exudate streams from the mucosa like smoke from a funnel. This exudate is largely fibrinous and rich in cells, chiefly polymorphonuclear leucocytes, but also lymphocytes and plasma cells. Areas of acute polymorphonuclear infiltration occur with more chronic areas characterized by a predominance of lymphocytic cells. Often the lower layers of the mucosa are eroded, although there is no epithelial defect. Except where a chronic

ulcer appears, the process is limited as a rule to the mucosa, although the submucosa in some instances shares in the inflammatory reaction.

The pathologic findings in duodenitis call attention to the work of Rosenow, as the lesions closely resemble those produced by him in animals by injecting specific strains of streptococci. Rosenow has recovered these strains from the tonsils and infected teeth in patients with ulcer of the stomach or duodenum, and also from inflammatory duodenal tissue removed at operation.



FIG 5—Polymorphonuclear infiltration in duodenal mucosa (x300)

In Table I is a summary of twenty-six cases of duodenitis. Fourteen patients were women and twelve were men. This differs from the usual ratio in chronic peptic ulcer in which the number of men is greater. The oldest patient was sixty-seven and the youngest twenty-seven. The average age of the women was forty-five and that of men thirty-nine. The average

age of the men and women considered together was forty-two. The longest period of symptoms was thirty-five years, the shortest one year, the average eleven years. In twenty-two cases the history was typical of duodenal ulcer and in four it was not typical. In one case there was a history of jaundice,

DUODENITIS

Summary of Cases of Duodenitis

Case	Sex	Age (years)	Duration of symptoms (years)	Hemorrhage	Rontgenogram		Acid		Excision	Excision and plastic operation	Excision and gastroduodenostomy	Appendectomy	Cholecystectomy	Cure	Great relief	Failure	Remarks
					Duodenal ulcer	Negative	Total	Frec									
1	F	51	11	+	+		20	0	+								
2	M	66	1		+		72	56	+			+			+		
3	M	40	6		+		34	20	+						+		
4	M	43	20	+	+		48	30	+			+		+			
5	M	28	10			+	42	34	+					+			
6	F	48	5		+		30	12	+			+		+			
7	F	39	1						+			+		+			
8	M	46	3		+		82	74	+			+		+			
9	M	27	3		+		56	38		+		+		+			
10	M	28	8		+		80	60		+							Post-operative bronchitis
11	F	44	5		+		48	28		+			+				
12	F	57	10		+		46	30		+					+		
13	M	34	15		Gastro-jejunal ulcer		42	36		+				+			
14	F	38	24	+		+	70	50			+	+		+			
15	F	27	10		+		66	48			+	+			+		
16	F	50	13		+			40			+	+			+		
17	F	41	20		+		70	50			+	+					
18	F	41	20		+		94	74			+		+				
19	M	42	7	+	+						+	+					
20	F	67	35	+	+		110	90			+					+	Died
21	F	35	10				50	30			+		+		+		Post-operative phlebitis
22	M	46	14		+		80	60			+	+					
23	F	34	15	+	+		82	68			+	+			+		
24	M	33	10		+		74	54			+	+		+			
25	M	38	14		+		80	60			+	+					
26	F	51	3		Complete obstruction		74	50			+	+		+			

but only duodenitis was found at operation. In one case typical gall-bladder colic had occurred, and at operation duodenitis and a diseased gall-bladder were seen, the gall-bladder was removed. A history of hemorrhage was obtained in six cases (23 per cent). In seven cases operation had been performed, in four appendectomy, in two gastro-enterostomy, and in one appendectomy, gastro-enterostomy and hysterectomy. Duodenal ulcer was



FIG 6 —Appearance of normal duodenum

diagnosed roentgenographically in twenty-two cases and gastrojejunal ulcer in one case. In two cases roentgenograms were negative and in one none was made. In one case only was there roentgenologic evidence of obstruction. The gastric analysis showed an average total acidity of 63 and an average free hydrochloric acid content of 46. The highest reported total acidity was 110 and the lowest 30, the highest free hydrochloric acid was 90 and the lowest zero. Three

types of operation were performed on the duodenum. In all cases the diseased area was excised, in eight simple excision was carried out, in five excision was combined with transverse sectioning of the pylorus, and in thirteen a portion of the anterior part of the sphincter was excised together with the inflammatory area, and gastroduodenostomy performed. Appendectomy also was performed in sixteen cases, cholecystectomy in three, and a gastro-enteric anastomosis was undone in one case. The convalescence of most of the patients was remarkably smooth. One developed mild bronchitis and another slight thrombophlebitis. One died five days after operation, the immediate cause of death being toxæmia and acidosis of unknown origin. At necropsy the operative wound was in good condition, but carcinoma was found in the body of the pancreas. There are authentic reports concerning eighteen patients, including the one who died. Of these, fifteen (83 per cent) are cured or greatly benefited, while two (11 per cent) report slight benefit as a result of the operation, a total of seventeen patients (94 per cent) who are benefited by the operative procedure.

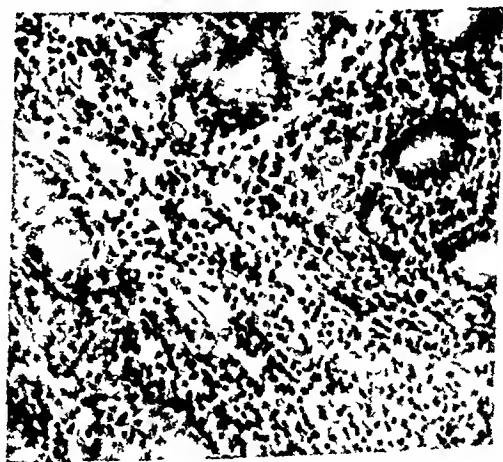


FIG 7 —Lymphocytic infiltration in submucosa (x120)

DUODENITIS

Discussion—Duodenitis like other tissue reactions varies in degree. The simplest form is seen at operation as a slight area of hyperæmia and faint stippling when the serosa is rubbed, the area involved usually being a circular patch 2 or 3 cm in diameter on the anterior surface of the duodenum just below the pylorus. The affected area may be cedematous and the serosal surface slightly dulled. In this simple form there is no deformity of the duodenum, but there may be slight pylorospasm. In the more advanced forms the area is red, hyperæmic and cedematous, and the stippling is marked. In a still later stage the duodenum is uniformly narrowed for a distance of several centimetres, and in extreme cases the circumference of the area is not more than 2 or 3 cm. In advanced cases there may be deformity of the duodenum, but no stellate scars, irregular contractions or punched-out lesions are seen in duodenitis. There may be adhesions of the omentum and gall-bladder or other organs to the lesion, but these are usually slight and easily separated. Dense adhesions and tumor such as are sometimes observed in cases of chronic perforating ulcer are not found. When the area is excised the mucosa is usually found intact, although in some

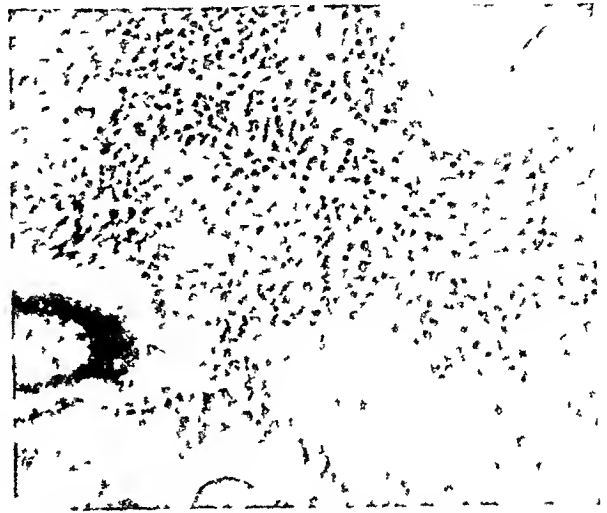


FIG 8—Lymphocytic infiltration of mucosa and submucosa (X120)



FIG 9—Edematous and congested serosa (X60)

instances there may be single or multiple small superficial abrasions. The wall of the bowel is generally somewhat thicker than normal. Duodenitis is not necessarily progressive in all cases. In some cases the inflammation is mild at operation in spite of a long duration of symptoms. In other cases in which the history is comparatively short, the pathologic changes are extensive. In each case also there are undoubtedly periods of exacerbation and remission of the disease

probably coincident with the occurrence of symptoms and freedom from them. Careful search in cases of duodenitis fails to show any evidence of chronic ulceration. In studying duodenums obtained at necropsy, we have found scars of varying size and thickness, indicating that ulcers had occurred at a previous time. In some instances the scar tissue could only be seen microscopically, and in these cases the old ulcers were evidently very superficial.

Chronic ulcers in healing leave marks varying from this minute form to the firm calloused scar involving all thicknesses of the wall of the bowel. Small acute ulcers and the superficial erosions occasionally seen in duodenitis involve the mucosal layer alone, and these heal without leaving a macroscopic scar. Chronic ulcers which have penetrated beyond the muscularis mucosæ always leave a scar. In duodenitis there is nearly always slight stippling on the posterior surface of the duodenum opposite the affected area, this, however, is never the result of true chronic ulceration, as the mucosa over the inflamed area is intact and no thickening or induration is felt on palpation.

In a microscopic section of the affected area are seen all the changes of

subacute and chronic inflammatory processes.

The epithelium is generally intact but may be denuded in a few small areas, in which case epithelial cells are seen in various stages of degeneration, and the surface is covered with fibrinous exudate rich in lymphocytes, plasma cells and occasional eosinophiles. In areas in which inflammation is more acute, a fair sprinkling of polymorphonuclear leucocytes is found (Fig 5). In most instances the mucosa and submucosa are affected and occasionally, the cellular infiltration



FIG 10 —Rontgenologic diagnosis duodenal ulcer with incisura, pathologic diagnosis duodenitis

extends through the muscle layers to the serosa (Figs 6, 7 and 8). There may be a perceptible increase in fibrous tissue, especially in the submucosa. Also the vessels of the submucosa show some engorgement, but this is most marked in the serosa which is generally congested and thickened (Fig 9).

European observers have found extensive gastritis in specimens resected for duodenal ulcer. We have limited the treatment of duodenal ulcer to gastro-enterostomy or local excision, and the stomach has not been studied pathologically. However, our observations lead us to believe that inflammation is, as a rule, fairly well limited to the first portion of the duodenum and the pyloric end of the stomach. We have, however, seen cases in which nearly the entire stomach as well as the duodenum appeared to be congested, cedematous and inflamed. Possibly it is in this type of case that extensive

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gastric resection should be performed. In stomachs resected for gastric ulcer we have found widespread gastritis which resembles duodenitis in all its details.

The problem of jejunal ulcer has always been a difficult one and here also an inflammatory lesion appears to play a part. We have operated in twelve cases diagnosed as jejunal ulcer, but did not find true ulcer. In such cases the jejunum is thick, distended, friable, red and oedematous and the mucosa is covered with tiny hemorrhagic areas. The wall of the stomach is usually greatly hypertrophied and the mucosa thickened and oedematous, but ulcerations, erosions and hemorrhagic areas are not prominent. We are unable to determine the significance of these findings, but just as we have observed cases with histories and Rontgen-ray pictures characteristic of duodenal ulcer in which no true chronic ulcer was found, so also there are cases in which the primary lesion is gastritis or jejunitis.

The exact relationship between duodenitis and chronic ulcer of the duodenum is not clear. Konjetzny and others have shown that in most

cases of chronic perforating ulcer of the duodenum, more or less extensive duodenitis is also present. Konjetzny in a single specimen has found all stages from simple cellular infiltration of the mucosa and superficial erosions to large chronic calloused ulcers. Pathologically the lesions are closely related, and according to Konjetzny a chronic ulcer forms as the result of unknown mechanical factors on the basis of chronic duodenitis. The importance of the acid factor is still undetermined. That chronic ulcers do not develop in all cases of duodenitis is probably due to a number of factors which at present cannot be accurately determined.

The clinical picture of duodenitis is practically identical with that of chronic duodenal ulcer. The patient is usually an adult in the third or fourth decade of life who has had periodic attacks of epigastric pain and distress coming on from two to three hours after meals and relieved by food and soda. The spells occur two or more times a year each lasting from a few



FIG. 11.—Rontgenologic diagnosis duodenal ulcer with marked spasm of bulb, pathologic diagnosis duodenitis.

days to several weeks, and are followed by free intervals of weeks or months. Diet relieves temporarily but does not cure the condition. Vomiting is not such a common feature in duodenitis, no doubt because stricture is not as common as in chronic ulceration. Spasm, however, may be marked. The average duration of symptoms in this series was eleven years. The general health of the patients is fair. Focal infection does not appear to be more prevalent than in the general run of cases observed at the Clinic. A history of gastric or intestinal hemorrhage was fairly common (23 per cent) in this series, more so than in the average series of cases of chronic duodenal ulcer. The congestion and tiny superficial abrasions noted in duodenitis readily

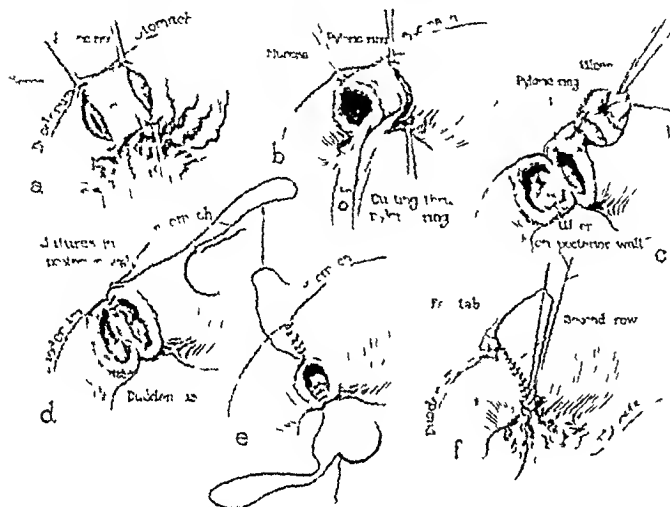


FIG 12 —Method of performing gastroduodenostomy

account for the hemorrhages. Physical examination as a rule is negative, although there may be tenderness in the epigastrium. The roentgenographic deformity in duodenitis, according to Carman, is the same as that in duodenal ulcer, except that a niche is never seen in duodenitis. Moore says that the spasm in these cases may be so marked as to pro-

duce a typical hour-glass deformity of the duodenum (Figs 10 and 11). A clinical diagnosis of duodenitis cannot be made and the presence of the lesion can only be determined by careful inspection at operation with the duodenum open and microscopic examination of the diseased tissue.

The most suitable therapeutic procedure in duodenitis is to excise the diseased area together with the anterior half of the pyloric sphincter, bring the cut ends of the stomach and duodenum together over the remaining posterior half of the sphincter and stitch them transversely with two or three rows of chromic catgut and silk (Fig 12). This gives better results than simple excision. We have performed the operation in a large number of cases of duodenitis and duodenal ulcer. The procedure is physiologically and anatomically ideal, in that the diseased area is eliminated and the normal continuity of the bowel maintained. The operation is only suitable for those cases in which the duodenum is sufficiently large and mobile to allow approximation of the tissues without tension. The lesion is usually limited to the cap of the duodenum and can then be excised readily, but there are cases in which the disease is too extensive to permit local excision, in these gastroduodenostomy or some other operative procedure must be carried out. Stricture

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or spasm of the pylorus does not follow excision by this method because a portion of the pyloric sphincter is removed. The results obtained are excellent, 94 per cent of the patients being cured or greatly benefited by the operation.

CONCLUSIONS

1 Duodenitis is a surgical and pathologic entity characterized by circumscribed or diffuse inflammation of the first portion of the duodenum without the formation of chronic ulcer.

2 The clinical picture and roentgenologic data are almost identical with those of chronic duodenal ulcer. No niche is seen in duodenitis.

3 The association between duodenitis and chronic duodenal ulcer is close. All chronic ulcers probably originate from duodenitis. The reason why duodenitis is not always followed by chronic ulceration has not been determined.

4 Gastritis and jejunitis are surgical and pathological entities, the full significance of which is not known.

BIBLIOGRAPHY

- ¹ Aschoff, L. Ueber die mechanischen Momente in der Pathogenese des runden Magengeschwurs und uber seine Beziehungen zum Krebs. *Deutsch med Wchnschr*, 1912, vol 1, pp 494-496.
- ² Aschoff, L. *Pathologische Anatomie*. Jena, Fischer, 1921, 591 pp.
- ³ Carman, R. D. Discussion. *Jour Am Med Assn*, 1924, vol lxxxiii, 1897.
- ⁴ Judd, E. S. Pathologic Conditions of the Duodenum. *Journal-Lancet*, 1921, vol xli, pp 215-220.
- ⁵ Judd, E. S. Excision of Ulcer of the Duodenum. *Journal-Lancet*, 1922, vol xlii, pp 381-385.
- ⁶ Judd, E. S., and Nagel, G. W. Excision of Ulcer of the Duodenum. *Surg, Gynec and Obst*, 1926. (In Press.)
- ⁷ Konjetzny, G. E. Zur Pathologie und chirurgischen Behandlung des Ulcus duodeni. *Deutsch Ztschr f Chir*, 1924, vol clxxxiv, pp 85-104.
- ⁸ Konjetzny, G. E. Ueber die Bedeutung der Gastritis und Duodenitis fur die Pathogenese des Magenduodenalgeschwurs. *Verhandl d deutsch path Gesellsch*, 1925, vol xx, pp 165-172.
- ⁹ Konjetzny, G. E. Entzündliche Genese des Magen-Duodenalgeschwurs. *Arch f Verdauungskr*, 1925, vol xxxvi, pp 189-226.
- ¹⁰ MacCarty, W. C. Excised Duodenal Ulcers. A Report of Four Hundred Twenty-five Specimens. *Jour Am Med Assn*, 1924, vol lxxxiii, pp 1894-1898.
- ¹¹ Mayo, W. J. The Contributions of Surgery to a Better Understanding of Gastric and Duodenal Ulcer. *ANNALS OF SURGERY*, 1907, vol xli, pp 810-817.
- ¹² Mayo, W. J. Ulcer of the Stomach and Duodenum with Special Reference to the End Results. *ANNALS OF SURGERY*, 1911, vol lvi, pp 313-320.
- ¹³ Mayo, W. J. Pathologic Data Obtained from Ulcers Excised from the Anterior Wall of the Duodenum. *ANNALS OF SURGERY*, 1913, vol lvi, pp 691-694.
- ¹⁴ Mayo, W. J. Progress in the Handling of Peptic Ulcer. *Jour Am Med Assn*, 1922, vol lxxix, pp 19-22.
- ¹⁵ Moore, A. B. Personal Communication.

- ¹⁶ Orator, V Beiträge zur Magenpathologie (histologische Untersuchungen an klinischen Resektionsmaterial) 1 Das Magen-Duodenal- und postoperative Jejunalgeschwür Virchow's Arch f path Anat, 1925, vol ccxv, pp 639-676
- ¹⁷ Puhl, II Über die Bedeutung entzündlicher Prozesse für die Entstehung des Ulcus ventriculi et duodeni Virchow's Arch f path Anat, 1926, vol cclx, pp 1-109
- ¹⁸ Rosenow, E C The Production of Ulcer of the Stomach by Injection of Streptococci Jour Am Med Assn, 1913, vol lxi, pp 1947-1950
- ¹⁹ Rosenow, E C Pathogenesis of Spontaneous and Experimental Appendicitis, Ulcer of the Stomach and Cholecystitis Jour Indiana State Med Assn, 1915, vol viii, pp 459-460
- ²⁰ Rosenow, E C The Causation of Gastric and Duodenal Ulcer by Streptococci Jour Infect Dis, 1916, vol xiv, pp 333-384

USE OF APPENDIX VERMIFORMIS IN THE FORMATION OF A URETHRA IN HYPOSPADIA¹

BY STUART MCGUIRE, M D

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DURING an early period of my professional career my father turned over to me a case of hypospadias. I was young, enthusiastic and eager to undertake any surgical adventure, hence I did not question his disinterestedness, but was gratified by the favor I thought he had conferred upon me. I studied the literature of subject and decided to follow the plan of treatment described in *Treves' System of Operative Surgery*, the recognized authority of that day.

The patient was fortunately the son of well-to-do and confident parents. First and last, I operated on him seventeen times during a period which covered over five years. Eventually I secured a remarkably satisfactory anatomical and functional result. This was proved by the fact that the boy contracted gonorrhea during his years of indiscretion, and became the father of four children after a marriage in later life.

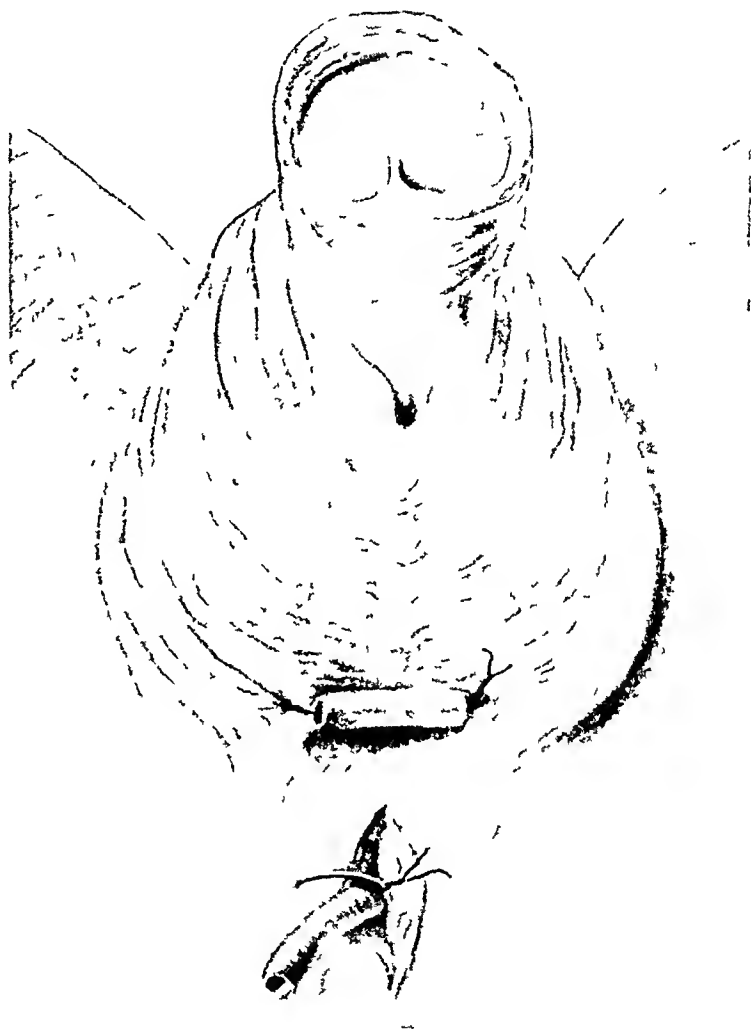


FIG. 1.—Perineal drainage preliminary to plastic operation. Occlusion of urethra anterior to opening by encircling ligature.—Re-drawn from Young.

Since this first case of hypospadias I have had others. They have come in bunches with intervals between during which I recovered my courage sufficiently to undertake the new cases. I never expected to write a paper on hypospadias, and my only purpose now is to call attention to a rather

¹ Read before the Southern Surgical Association December 14, 1929.

novel method of forming a new urethra which I have employed successfully in three cases. The method is new to me, although it may have been used before by other operators †

Those who desire to make a thorough study of hypospadias are referred

to the contributions of two Fellows of this Association, one by James E. Thompson, of Galveston, published in the Transactions for 1916, and the other by Hugh H. Young, of Baltimore, printed in his *Practice of Urology*.

Before undertaking a case, it is very important for the surgeon to have a frank talk with the family of the patient, and explain the time it will probably take, and the number of operations that may be necessary, to correct the abnormal condition present. They may be assured of the safety of the surgical undertaking and the probability of a satisfactory final result, but they should be told of the likelihood of frequent partial failures before ultimate success is attained. An ounce of warning is worth more than a pound of explaining.

The time of election

for the operative procedure is between the seventh and fourteenth year. If the work is undertaken too early the parts are so small and the tissues so

† I have since found that in a paper published in *ANNALS OF SURGERY* for April, 1919, entitled "Transplantation of the Vermiform Appendix into the Female Bladder to Supply an Absent Urethra," Dr. Charles M. Rosser of Dallas, Texas, suggested the use of the appendix in the cure of hypo- and epi-spadias.



FIG. 2.—Perineal urethrostomy for drainage without tube.—Redrawn from Young.

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delicate that plastic operations are difficult. In addition it is impossible to secure the cooperation of the little patient, as he cannot understand why he is hurt, or how he will be benefited. If the work is undertaken too late convalescence will be complicated by erections of the penis, which may tear out stitches and jeopardize the success of the operation. Delay may also engender a morbid state of mind from a consciousness of an abnormal sexual condition that will be difficult to overcome.

Before beginning any plastic operation on the penis it will be wise in most cases to establish perineal drainage of the bladder in order to prevent soiling the wound with urine. This may be done temporarily by an incision through the perineum and the insertion of a catheter into the bladder, with the occlusion of the urethra anterior to the opening by an encircling silk suture tied moderately tight over a small pad of gauze. It may be done more permanently by making an incision through the perineum and suturing the mucous membrane of the urethra

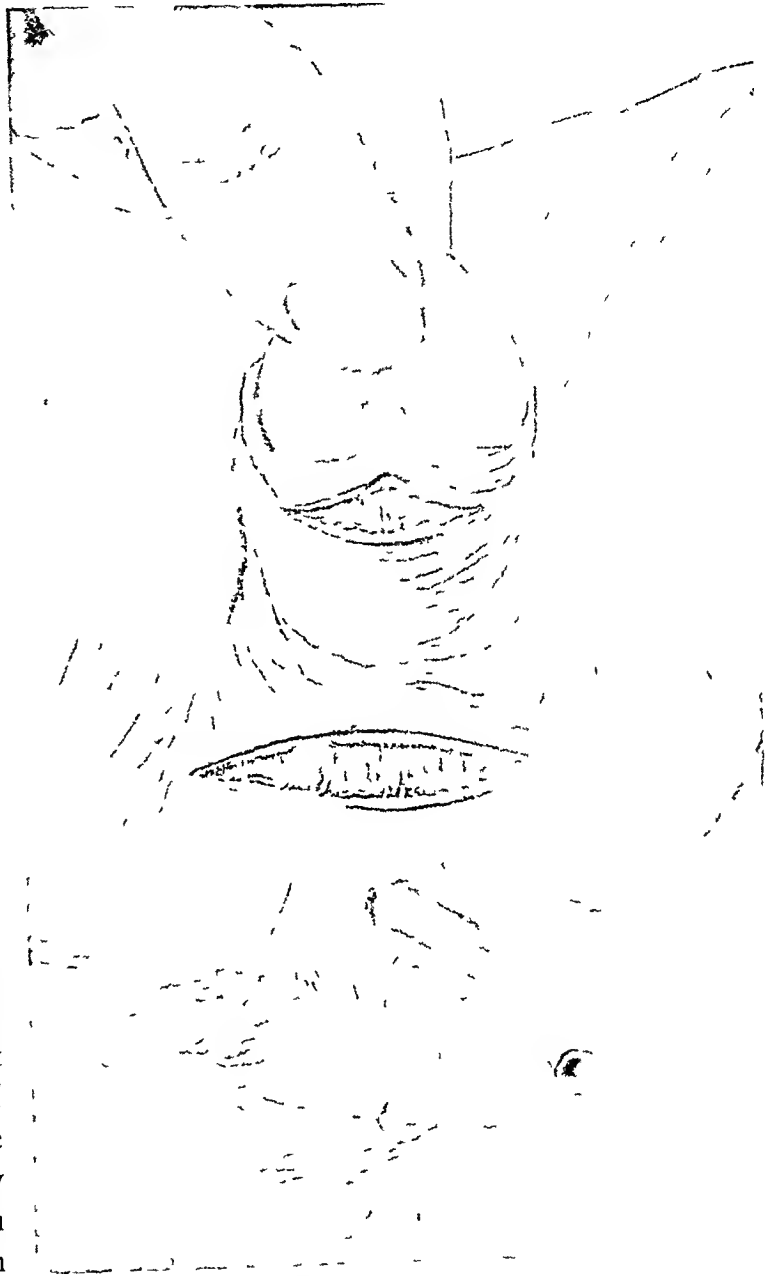


FIG 3—Transverse incisions to correct congenital chordee. Redrawn from Young

to the skin, thus producing a fistula through which the urine will escape. If a urethrostomy is done the opening should not be closed until the series of operations for hypospadias is completed, although this may take several years.

The cure of hypospadias consists essentially of three steps. First, the correction of the deformity of the penis, second, the formation of a new urethra from the glans to the hypospadiac opening, and third, the connection of the two channels at the point where they meet. Of these the first is the easiest but by far the most important. The correction of the congenital chordee

which always exists to a greater or less degree in these cases, is accomplished by making a transverse incision on the under side of the penis, dissecting out all constricting fibrous bands, and suturing the cut longitudinally. If one incision is not sufficient to straighten the penis, then a second similar one

should be made above or below it. If too much tension results it can be relieved by an opposite plastic, consisting of a longitudinal incision on the dorsum of the penis with transverse closure. If the first attempt to correct the deformity is not successful, then the operation should be repeated. Unless the penis is properly lengthened and straightened before the formation of the new urethra, the final result will not be satisfactory.

The difficulties in the formation of the new urethra will depend largely on whether the hypospadiac opening is glandular, penile or perineal. Other things being equal, the longer the channel the more difficult the task. Various plastic operations have been devised to form the urethra by Beck, Duplay, Mayo, Thompson, Russell and others. I will not attempt to describe them, but they are all

FIG. 4—Transverse incisions sutured longitudinally to straighten and lengthen penis—Re-drawn from Young

attended by frequent partial failures which are most disappointing and disheartening. Surgeons who have had personal experience with these operations will read with sympathetic understanding the following review of his work by Hugh H. Young:

"The study of results show that in almost all instances one or more small breaks occur in the line of sutures and fistula may form. These may be due to tension, infection,

imperfect circulation and uncontrollable erections. Occasionally the glandular portion has completely broken down. In other cases the glands have remained intact and one or two small fistulae have formed, generally immediately back of the glans and at the point of closure over the old meatus. Subsequent operations were required and sometimes repeated two to three times before every fistula was healed. Occasionally pin-point openings, which caused little or no inconvenience, were extremely difficult to close and sometimes remained regardless of all efforts."

About three years ago I had an unusually hard day's work ahead of me. One of the patients to be operated on was a boy with hypospadias, whose penis I had straightened some six months previously. In making out the schedule of operations I put the case of hypospadias last on the list in order that I might be able to give it all the time it required. As I worked that day the satisfaction I felt as I finished each case at the progress I was making was marred by the recollection of the tedious and time-consuming operation for hypospadias that was yet to come.

One of the last cases was a woman with fibromyomata of the uterus. After I did the hysterectomy I looked at her appendix. It was unusually long, large and healthy. I was suddenly seized with an inspiration to use it in some way to make the new urethra for the boy. I removed the appendix and put it in a basin of normal saline solution.

When the patient with hypospadias was being anesthetized, I cut off the tip of the appendix and washed out its interior by injecting saline through its lumen with a syringe. I then passed a No. 10 F soft rubber catheter through it. I next placed it on a flat pad of moist gauze and got a nurse to steady it by holding each end of the catheter. With a sharp knife I made a longitudinal incision from one end to the other of the appendix opposite the mesenteric attachment going through the serous and muscular coats but not through the submucosa and mucous lining. I caught the edges of the

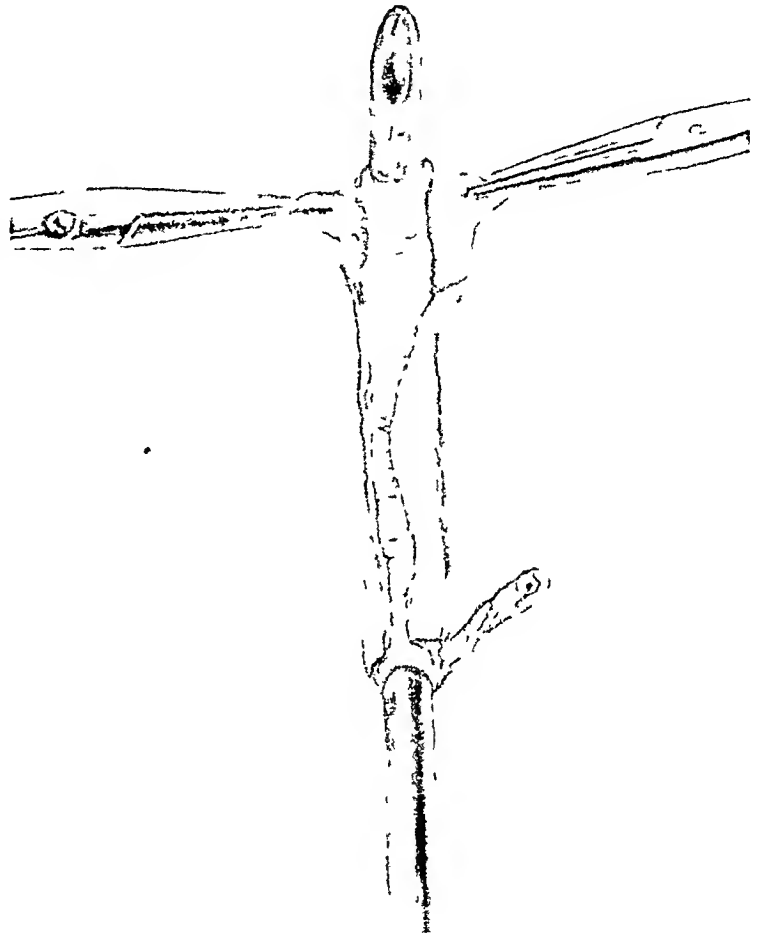


FIG 5.—Appendix threaded on catheter. External coats being removed from sub-mucosa and mucous lining.

incision with forceps and by stripping with gauze I easily peeled the outer coats off and left a tube of mucous membrane threaded on the rubber catheter. I finally tied a circular ligature of silk around the distal end of the catheter and its covering of mucous membrane to prevent them slipping, cut one end of the ligature short and carried the other end by means of a curved needle through the eye of the catheter and out at the centre of its conical tip.

This was done with the purpose of using the suture as a tractor to draw the catheter and tubular graft of mucous membrane through the track I proposed to make in the penis of the patient.

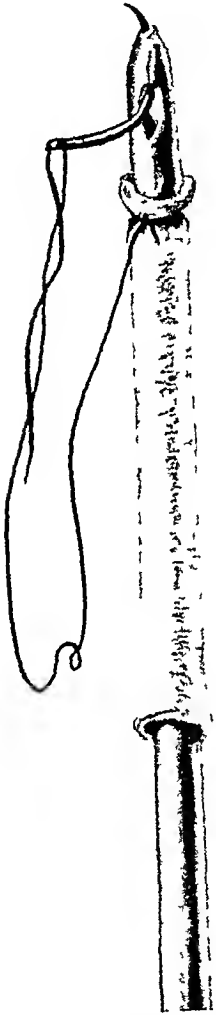


FIG 6—Mucous lining of appendix tied on catheter. Traction suture.

The boy was placed in the dorsal position on the table and his penis flexed on his abdomen so that it lay on a pad of gauze with its ventral surface uppermost. A stab wound was made in the glans penis at the site of the normal urethra opening and a short transverse incision was made through the skin just anterior to the hypospadiac opening, which was at the junction of the penis and scrotum. The point of a large trochar armed with a canula was inserted into the stab wound in the glans and the instrument was forced along the penis beneath the skin until its point emerged at the incision at the hypospadiac opening. The trochar was withdrawn, leaving the canula in place. The butt end of a fenestrated probe was passed down the canula, and the suture threaded on it. It was hoped that by traction on the suture the catheter could be drawn through the canula, but it proved too large to go through its lumen. However, by drawing the tip of the catheter firmly into the opening of the canula, it readily followed the instrument as it was withdrawn.

The catheter with its covering of mucous membrane was now in the desired position. Its two ends were cut off so that they projected only about one-half inch. The circular edges of the two ends of the graft were everted and sutured by several silk stitches to the mucous membrane of the glans above and to the skin at the base of the penis below. The parts were then dressed with sterile vaseline.

The section of rubber catheter was allowed to remain in place for one week. When it was removed there was some superficial necrosis at the two ends of the graft, but the wound was otherwise in good condition. Two or three days later dilatation of the channel was begun by passing a No. 12 silk ureteral catheter through it. There was no obstruction or tendency to

contraction The boy soon learned to pass the instrument himself, and was shortly sent home Six months later he returned to the hospital and the new urethra was found to be most satisfactory The urinary fistula at the base of the penis was then closed by a plastic operation

Since the case above reported I have had two others on whom I have operated, using the same method with equally good results

I have now on hand a fourth case, whose condition will put a severe test to any surgical procedure employed for its relief At the boy's birth the obstetrician pronounced him a girl, and as such he was christened and raised When he was three years of age his mother became uncertain as to his sex, and took him to Doctor Russell, of Baltimore, for examination, who told her the child was a male, but advised postponing any operative intervention until he was older

The mother carried the child home and was then confronted with the problem of changing his name She was a woman of strong religious convictions and her conscientious scruples were only reconciled by a second baptism which caused considerable gossip among her neighbors

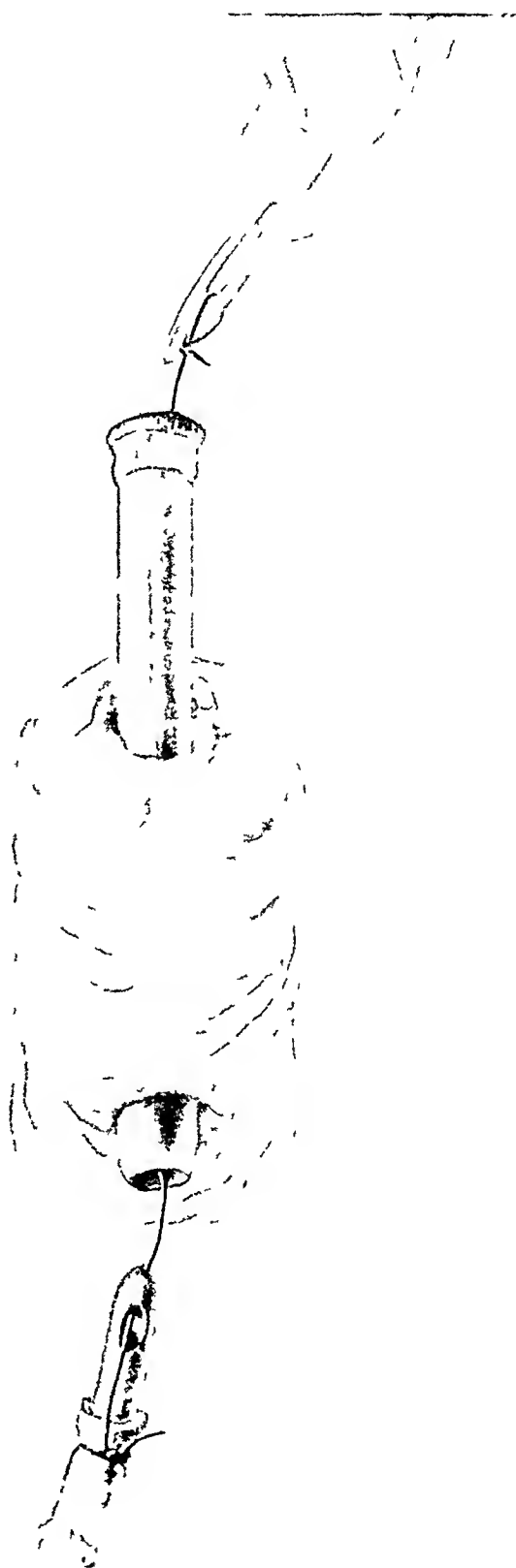


FIG 7 —Trocar withdrawn—Canula in tract of new urethra

When the boy came to me about two months ago he was fourteen years of age and was masculine in development. Examination showed the urethral orifice in the perineum about an inch in front of the anus. The scrotum was cleft but the testicles could be palpated on either side. The general appearance was not unlike that of two large labia majora. The penis was curled downwards and backwards and hooded over with skin which bound it in its abnormal position, so that it could readily have been mistaken for a large clitoris.

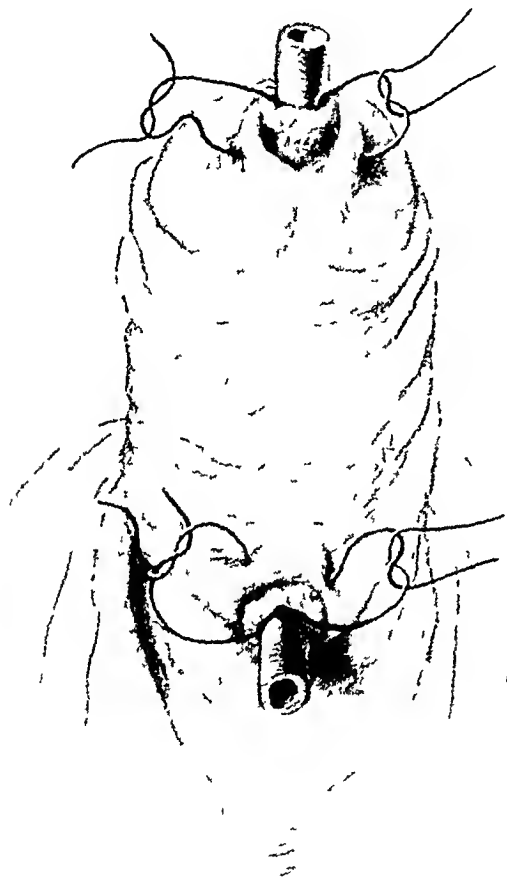


FIG. 8 — Mucous lining of appendix in position

By a plastic operation I corrected the bifurcated scrotum and developed a rather formidable penis. I sent the patient home with instructions to return in six months if he wished me to attempt to create a new urethra. I sincerely trust he will be satisfied with the cosmetic result of what has been done for him. If he returns, as I fear will be the case, I will have to keep him waiting until I find a donor with an unusually long appendix, or else splice two together, as the distance from the tip of the glans penis to the hypospadiac opening in the perineum is at least six inches.

AUTHOR'S NOTE — In the discussion of this paper, Dr. Hugh H. Trout, of Roanoke, Va., said he had learned of the work I was doing through one of my associates and he had employed the method with satisfactory results in one case. The patient was a negro boy fifteen years of age with hypospadias of the penile type. Doctor Trout removed his appendix and used the mucous lining to form the new urethra. He thought when it was impracticable to use the patient's own appendix it was desirable to match the donor with the patient as was the custom in blood transfusions.

Dr. Robert H. Morris of New York said he remembered that some years ago Dr. Charles M. Rosser of Dallas, Texas, had reported a case of a woman with traumatic injury of the neck of the bladder whose urethra he had restored by using the appendix.

Dr. V. P. Blair of St. Louis, Mo., said he was much surprised at the results secured in the cases reported, because in his experience no graft would grow that was transplanted from one individual to another. In his own work he had been very successful

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with autographs or the transplantation of the skin of a patient from one part of the body to another, but that he had always failed with heterographs or the transplantation of the skin of one patient to another

In closing the discussion I said that I was familiar with Doctor Blair's views which were stated in his book on *Plastic Surgery*, and at the time I used the mucous membrane of the appendix of a woman to make the urethra for the boy I regarded the operation as an experiment and really did not expect it to succeed. I was not now certain that the mucous membrane had grown as a graft. It may have done so, but on the other hand the reticulated sub-mucosa may have simply acted as a scaffolding on which the individual cells proliferated, or finally owing to the persistency with which the tract was kept open by mechanical dilatation, after the operation it is possible the epithelial lining may have resulted from the growth of epithelial cells from the mucosa of the glands and the skin of the perineum. Be the explanation what it may, the practical fact is that by the use of the method described there are now three cases of hypospadias with open channels which permit the passage of urine.

Despite my respect for Doctor Blair's opinion, I wonder whether his statement that it is impossible to successfully transplant skin from one individual to another can be true. It is certainly contrary to the teachings of the older text-books and to the present practice of many experienced surgeons. I can now recall numerous cases in which I thought I had employed heterographs successfully.

Doctor Blair knows infinitely more about skin grafting than I do. With what he says about his practical and experimental work, it seems possible that I have been mistaken in the credit I gave skin grafting in my practice. It is possible the grafts only acted as a protective and stimulating dressing. I shall give the question further thought and study, but I must admit that at this time I believe heterographs will grow.

SUTURE TECHNIC FOR ABDOMINAL CLOSURE IN CASES OF DRAINAGE*

By FRANCIS REDER, M D
OF ST LOUIS, MO

THE principal object in effecting a good closure of an incisional wound of the abdominal wall, not infected, is to prevent the formation of a post-operative hernia

With our present method of the *étagen* suture and the excellent absorbable suture material at our disposal, the apprehension of the surgeon relative to such an unfortunate happening, has been greatly lessened

This is a happy retrospect when the unsatisfactory results of the "through-and-through" suture in the early days of antiseptic surgery are recalled

It is quite true, however, that even with the enlightened progress in this particular phase of surgery, post-operative hernias in non-infected cases are still surprisingly large

For the chief causes of post-operative hernia, apart from some constitutional disease, such as syphilis, which prevents rapid and sound healing, we must look to sepsis of the wound as the agent responsible for the greatest number of cases

The prolonged use of drainage, a badly chosen incision, imperfect suturing, poor suture material, neglect in arresting bleeding with a resultant hæmatoma of the abdominal wall, and perhaps the premature subsection of the operative scar to strain, are other factors. Most of these cases reflect to a certain extent upon the operator, and are preventable

To indifferent suturing, next to infection, must be attributed a large number of post-operative hernias for which no other explanation can be offered

In a paramedian wound it is well to bear in mind that the aponeurotic structures, which are the chief barriers against protrusion of the abdominal viscera, show a great difference in their anatomical construction. For instance, in the upper abdomen the direction of the fibres in the posterior rectus sheath is at right angles with the line of incision. The fibres are almost all transverse in this sheath. Attempts at suturing will often be unsuccessful, unless there is sufficient relaxation of the patient to relieve the strain, otherwise the suture will cut out. With the anterior layer it is different. Here the construction of the sheath shows an interlacing of its fibres. When the edges of the aponeurosis have been sutured together, there is little likelihood that the suture line will not successfully resist great tension. This is a protection for the deep line of suture.

The suture technic of an abdominal wound in the presence of pus that

* Read before the Southern Surgical Association, December 15, 1926

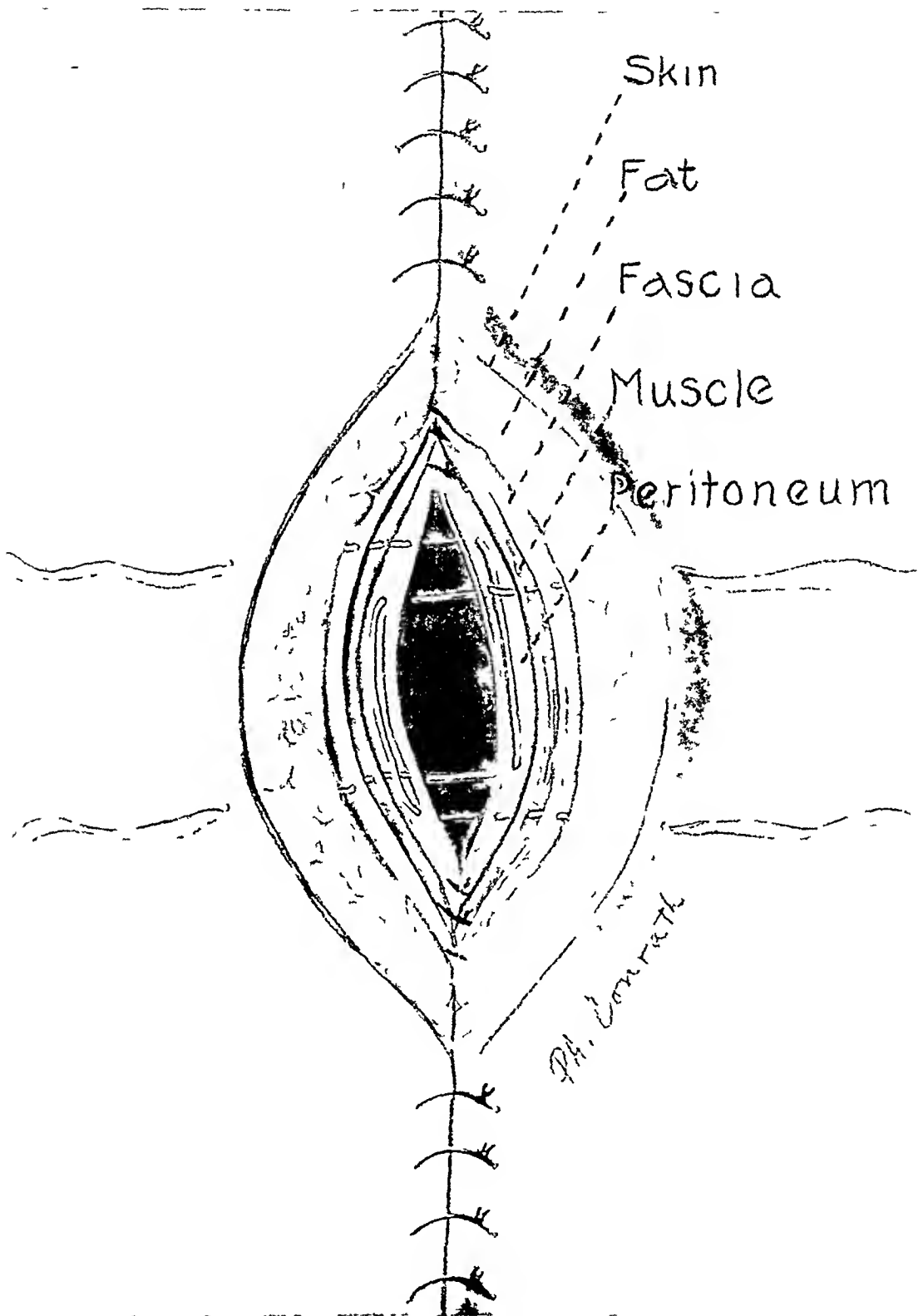


FIG. 1.—Twin mattress suture introduced through posterior rectus sheath and peritoneum. The suture material for convenience of identification is iron dyed (black) silkworm gut. The suture enters the skin about $\frac{1}{4}$ inch from the wound margin. It passes through the anterior muscle and fat and pierces the posterior rectus sheath including the peritoneum $\frac{1}{4}$ inch from the margin. The suture then carries across the wound and engages the opposite structures i. e. peritoneum and posterior rectus sheath pierces them from within out $\frac{1}{4}$ inch from the margin. The suture then incorporates the fat and muscle and pierces the posterior rectus sheath and peritoneum and the peritoneum from inside out $\frac{1}{4}$ inch from the wound to the opposite structures i. e. peritoneum and posterior rectus sheath and fat and muscle and pierces out $\frac{1}{4}$ inch from the margin. It is then made opposite the entry point and carried across the wound on a line $\frac{1}{2}$ inch below the point of entry. The opposite suture is then carried across the wound and pierces the opposite suture an interval of $\frac{1}{2}$ inch and should be allowed for its escape.

was in evidence prior to the operation, differs but little from the technic applied to a non-infected wound

In an infected wound the abdominal closure cannot be effected completely as there must remain an opening for drainage. The part of the wound not

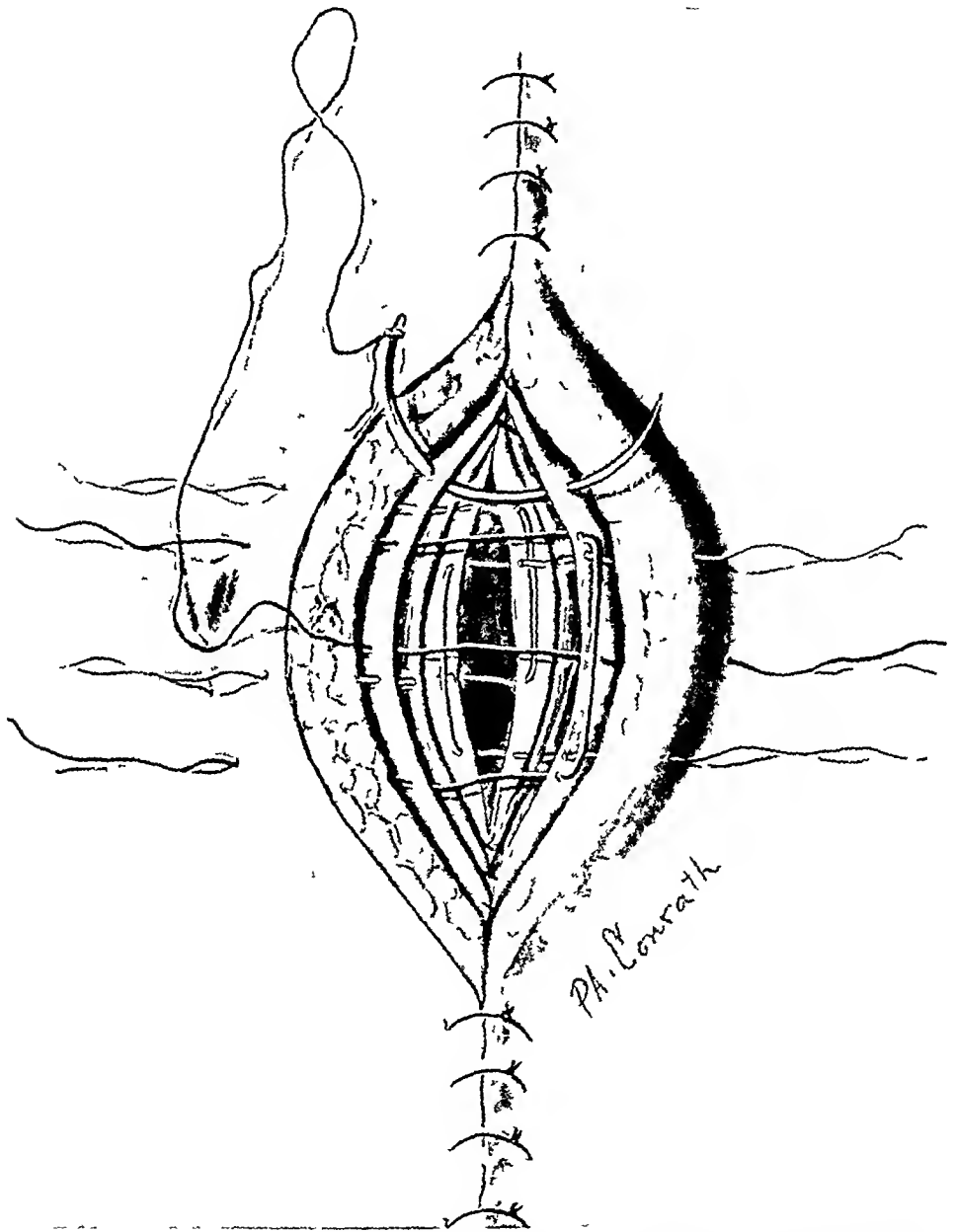


FIG 2 —Twin mattress suture introduced through anterior rectus sheath. The suture material used is the undyed (white) silkworm gut for convenience of identification. The technic for the introduction of this suture is similar to that employed in placing the deeper suture. The only interposing structure which is penetrated is the fat between the skin and aponeurosis

implicated in drainage should receive the same careful attention in the accurate apposition of its structures as a case free from sepsis, *ie*, the patient's condition permitting. This has been impressed upon me when in some of my infected cases the wound was smeared with pus and primary union of the abdominal wall resulted

ABDOMINAL CLOSURE IN CASES OF DRAINAGE

The drainage opening, if certain precautions are taken, should cause but little concern as to the future functional results of the abdominal wall. By these precautions I mean the introduction of a certain type of suture at the time of operation into the aponeurotic structures bordering on the drainage

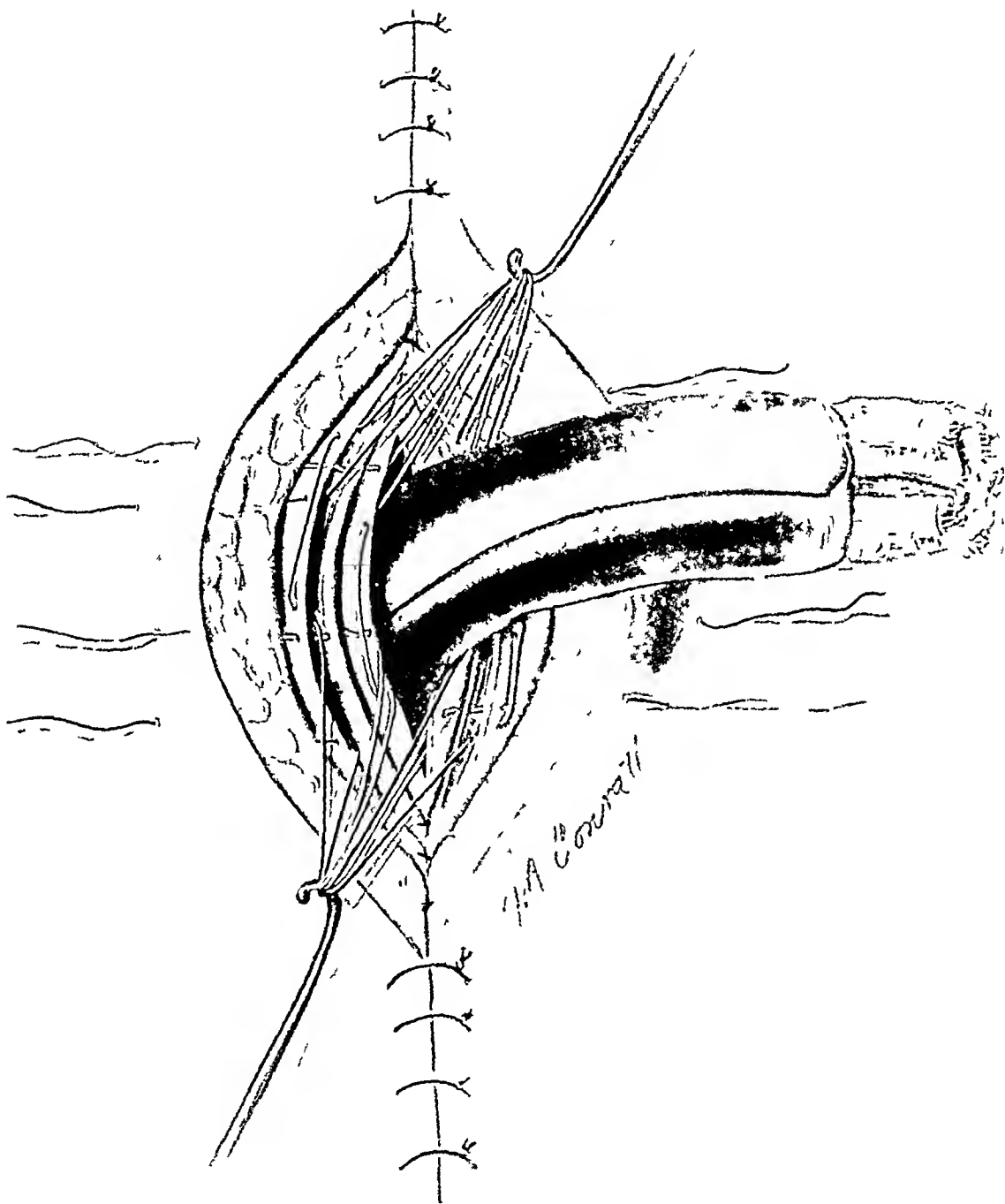


FIG. 3.—The twin mattress sutures are in place and the still open drainage opening is held apart for the introduction of the drain. After the removal of the drain the traction upon the respective sutures will close the wound with perfect apposition of the aponeurotic structures. The sutures are secured individually and tied over a small object.

opening. These sutures are placed in such a manner that after the removal of the drain traction upon them in opposite directions will cause an accurate apposition of the divided structures. For want of a better term I have called this suture the "twin mattress suture."

The material used is silkworm gut. For the posterior rectus sheath iron dyed silkworm gut, on account of its black color, is used. For the anterior rectus sheath the undyed silkworm gut is employed. It is necessary to use suture material of a different color to simplify the identification of the fascial structures carrying the different sutures.

The suture is introduced through the skin about three-quarters inch from the wound margin. It passes through the anatomical structures and penetrates the posterior rectus sheath, including the peritoneum an eighth of an inch from its edge. The suture is then carried across the wound and engages the opposite posterior rectus sheath, piercing it and the peritoneum from within out and about an eighth of an inch from the aponeurotic margin. This suture incorporates about half an inch of the body of the posterior rectus sheath, and piercing it from without in it is again carried across the wound to the opposite posterior sheath, which it penetrates, including the peritoneum, from within out about an eighth of an inch from its margin. It then pierces the anatomical structures in its path as it emerges on a line a half inch below the point of entry.

The opposing suture is placed in a similar manner. In introducing the opposing suture an interval of an eighth of an inch should be allowed for tissue play. The technic for placing the sutures in the anterior rectus sheath is similar to that of the posterior sheath. In this region the only structure interposing between skin and aponeurosis is fat.

In a wound three inches long, which can be considered a large drainage wound, three "twin mattress sutures" will answer the purpose. After the sutures are in place the strands stretching across the wound are pulled aside to facilitate the introduction of the drain. The ends of the sutures are properly cared for so that they can be readily assembled and tied over a small roll of gauze after the drain has been removed.

No haste should be made in removing the "twin mattress sutures," and nothing less than two weeks after the removal of the drain should be considered.

This method of suturing has given me excellent results in cases where the liability for a post-operative hernia was great.

THE TREATMENT OF TETANUS

By SAMUEL OSCAR FREEDLANDER, M D

OF CLEVELAND, OHIO

FROM THE UNIVERSITY SURGICAL CLINIC OF THE CLEVELAND CITY HOSPITAL

THE purpose of this report is to record a series of 25 consecutive cases of tetanus, treated uniformly and analyzed so as to offer a basis for some conclusions regarding the therapeutic value of tetanus antitoxin when used intravenously. If others will consistently use one method of treatment in a series of cases, and analyze them in a similar manner, eventually there will be some firm basis for the use of antitoxin. In many cases of this series, excessive amounts were used. This was done in order to satisfy ourselves as to its therapeutic limits when used intravenously.

It is generally agreed that antitoxin is the only measure which has thus far offered any hope of success in the treatment of tetanus. However, its real value is still in doubt, largely because tetanus statistics are so unreliable. Very few series of tetanus cases have been reported, throughout which, there has been any consistency in the size of dosage or mode of administration of antitoxin.

The gross mortality rate of tetanus in pre-serum days, that is before 1896, was 75 to 85 per cent. This is deduced from sources such as the Civil War,¹ the Franco-Prussian War,¹ Guy's Hospital,¹ Massachusetts' General Hospital,² etc. In isolated instances there were collections from various sources with much lower mortality rates, such as Curschmann's series,¹ in 1889 of 912 cases with a rate of 44.1 per cent, and Curling's¹ of 128 cases at the rate of 54.5 per cent.

The inverse relation of the incubation period to the mortality rate has long been known, the longer the incubation period the less the death rate. Jacobson,¹ in 1906, analyzed a large number of these earlier reports and showed that for cases with an incubation period under ten days the rate was 83 per cent and only 43.6 per cent if the incubation period were ten days or more. Thus the gross mortality rate unless analyzed for at least the incubation period is of little value for comparative purposes.

Since the use of antitoxin has become widespread, and especially in recent times when large doses have been used, the reports of tetanus cases show a lowered mortality rate.

In 1923 Miller,² reported from Massachusetts General Hospital

Since 1896—96 cases mortality rate 67.7 per cent

Since 1910—45 cases mortality rate 57.8 per cent

Since 1916—25 cases mortality rate 52 per cent

In 1918, Cooper⁴ reported 102 cases with a rate of 55 per cent

In 1921 Stone⁵ 40 cases with a rate of 55 per cent

In 1922 Ashhurst,⁶ 18 cases with a rate of 33 per cent and many others with rates around 50 per cent.

Figures from the last war are of little value because practically all of the cases had had one or more prophylactic injections of antitoxin. When prophylaxis does not prevent tetanus it has the effect of prolonging the incubation period and also increasing the incidence of local tetanus, both of which reduce the gross mortality rate. Bruce⁷ showed that in 1,429 cases which developed the disease after having had prophylactic injections, the average incubation period was thirty-nine days and the mortality rate 21 per cent, while in the non-protected cases, the incubation period was eleven days and the mortality rate 57 per cent. The treatment was about the same.

None of these statistics allow us to draw accurate conclusions as to the value of antitoxin because (1) there is a tendency to report only the successful series, (2) there is no uniformity in any one series as to the doses of antitoxin, the mode of injection or the adjuvant use of other measures, (3) many of the groups make no mention of the incubation period.

The series reported in this paper consists of 25 cases, which were treated at the Cleveland City Hospital between 1918-1926. The treatment was uniform in that large doses of antitoxin were injected intravenously at frequent intervals. The following regime was used:

(1) The local treatment of the wound consisted of making all parts accessible to the air by the removal of devitalized tissue. In many cases the wound was of little consequence. A small amount of antitoxin was usually injected around the wound.

(2) Within the first twenty-four hours a total of 50,000 to 150,000 units of antitoxin was given intravenously, divided into three to five injections. Thereafter a daily dose of 15,000 to 150,000 units intravenously in from two to three injections. This was continued well into convalescence, sometimes as long as twelve to fifteen days, depending upon the muscular rigidity. In the later cases injections were not continued as long.

(3) Morphine was given hypodermically every six hours, and chloretone every six hours by rectum.

(4) Food and fluids were urged.

The rationale of this treatment is as follows:

From confirmed experimental data,^{8,9} it is known that tetanus toxin appears early in the blood stream, and it is from here that it is taken up by the motor nerve endings. It has been shown that tetanus antitoxin can only neutralize the toxin which is in the blood stream. Toxin already bound by the central nervous system cannot be influenced. Furthermore, antitoxin is excreted very rapidly. The aim of treatment should be to maintain a high concentration of antitoxin in the blood in order to neutralize whatever toxin is already there and also that which is being given off from the focus of infection. Thus the toxin would be neutralized before being taken up by the nerve endings. The most practical way to maintain a high concentration in the blood stream is by repeated intravenous injections. Intraspinal injections, theoretically, offer the slight advantage of neutralizing more directly the small amount of toxin in the spinal fluid, which would also be neutralized

THE TREATMENT OF TETANUS

TABLE I

Name	Age	Location of wound	Incub period	Duty treat	Antitoxin injected 1st 24 hrs	No of inj 1st 24 hrs	Total amt	Hosp day	Result	Remarks
W R	11	Hand	7 days	1 day	144,000	5	364,000	23	Recovered	None
W K	6	Foot	18 days	3 days	90,000	3	270,000	16	Recovered	None
I N	10	Foot	10 days	1 day	60,000	3	178,000	26	Recovered	None
B A	18	Thigh	8 days	1 day	160,000	5	590,000	54	Recovered	None
F H	34	Foot	8 days	1 day	65,000	3		27	Recovered	None
M B	39	Hand	?	15 hrs	55,000	2	55,000	11 hrs	Died	None
A B	8	Foot	11 days	3 days	45,000	3	194,000	36	Recovered	None
M R	11	Hand	5 days	1 day	90,000	3	190,000	2	Died	None
R M	9	Arm	21 days	2 days	80,000 {40,000 spin	2	757,000	23	Recovered	Chill, mtr mtr
A M	7	Foot	6 days	1 day	60,000	2	60,000	12 hrs	Died	None
I S	34	Toe	9 days	3 days	70,000	3	695,000	18	Recovered	None
P N	33	Foot	60 ?	1 day	50,000	1	50,000	13 hrs	Died	None
T M	49	Foot	7 days	1 day	68,000	2	68,000	6 hrs	Died	None
I S	7	?	?	3 days	48,000	2	296,000	18	Recovered	None
E G	4	Foot	10 days	3 days	40,000 {15,000 must	2	330,000	24	Recovered	None
F Z	33	?	?	1 day	105,000	4	545,000	30	Recovered	Chill, mtr mtr
C N	36	?	?	4 days	60,000	2	90,000	36 hrs	Died	None
J W	18	Head	6 days	1 day	80,000	3	80,000	18 hrs	Died	None
E C	8	Foot	14 days	6 days	60,000	2	789,000	49	Recovered	Chill, mtr mtr
G B	43	Finger	7 days	10 days	63,000	3	233,000	27	Recovered	None
W A	8	?	?	2 days	110,000	5	345,000	29	Recovered	None
W S	5	Foot	4 days	1 day	50,000	3	610,000	3	Recovered	None
I S	11	Foot	12 days	2 days	195,000	5	575,000	33	Recovered	None
L H	8	Foot	7 days	1 day	100,000	4	100,000	15 hrs	Died	None
E M	13	?	?	4 days	100,000	4	170,000	48 hrs	Died	None

from the blood stream, while practically, there is the difficulty of doing repeated spinal punctures on spastic tetanus patients. Antitoxin is not taken into the central nervous system from the spinal fluid.⁹ Recently Wainwright¹⁰ has emphasized the value of the intravenous use of antitoxin in large doses.

From the chart it will be seen that the gross mortality rate was 36 per cent. There were 11 cases with an incubation period of less than ten days, of which 45.5 per cent died. Eight cases with an incubation period of ten days or over had a mortality rate of 12.5 per cent, and of six cases with an incubation period unknown, 50 per cent died. Six of the nine deaths occurred within the first twenty-four hours after entrance into the hospital, and the other three within forty-eight hours. If the deaths within the first twenty-four hours are excluded, that is cases in which there was not time to administer sufficient toxin, the mortality rate would be 12 per cent.

It will be noted that in spite of the large doses, only three patients showed any sharp reaction, such as chill and urticaria. The same patients who reacted with a chill, developed urticaria several days later.

The amount of antitoxin given within the first twenty-four hours to the cases surviving that period, averaged 85,000 units. This was given in an average of three doses intravenously.

No doubt in many cases the antitoxin was continued longer than necessary, thus making the total doses too high. It was our impression at first

TABLE II
Summary (City Hospital 1918-26)

	No.	Cured	Died	Mortality
				Per cent
Incubation less than 10 days	11	6	5	45.5
Incubation 10 days or more	8	7	1	12.5
Incubation—unknown	6	3	3	50
Total	25	16	9	36

that if the injections were discontinued earlier the muscular rigidity and increased reflex-excitability persisted longer. This impression has not been confirmed with increased experience. It is doubtful whether it is necessary to continue the antitoxin longer than six or seven days.

The routine which we follow now is

1st 24 hours 100,000 units 4-5 doses
 2nd 24 hours 80,000 units 3-4 doses
 3rd 24 hours 60,000 units 3 doses
 4th 24 hours 40,000 units 2 doses
 5th 24 hours 20,000 units 2 doses
 6th 24 hours 10,000 units 2 doses
 7th 24 hours 5,000 units 1 dose

This gives a total of 315,000 units for the average case.

THE TREATMENT OF TETANUS

SUMMARY

Twenty-five consecutive cases of tetanus were treated with large frequently repeated intravenous injections of antitoxin, with a mortality rate of 36 per cent. Eleven of these had an incubation period of less than ten days with a mortality rate of 45.5 per cent. If the six cases which died before sufficient antitoxin could be administered are excluded, the mortality rate would be 12 per cent.

The relatively low mortality rate in this series adds to the impression that tetanus antitoxin given in large doses intravenously has some therapeutic value.

It is hoped that others will record a series of cases, giving antitoxin consistently by some other route, so that the results may be compared.

REFERENCES

- ¹ Golla, F. *Lancet*, vol. 11, p. 966, December 29, 1917.
- ² Miller, R. H. *Surg., Gyn. and Ob.*, vol. XXVI, p. 90, January, 1923.
- ³ Jacobsen. Quoted from Keen's *Surgery*, vol. 1, p. 493.
- ⁴ Cooper. *Lancet*, vol. 11, p. 930, December 29, 1917.
- ⁵ Stone, W. J. *J. A. M. A.*, vol. LXVIII, p. 1939, June 24, 1922.
- ⁶ Ashhurst, A. P. *Arch. Surg.*, vol. 1, p. 407, November, 1920.
- ⁷ Bruce, D. J. *Hygiene*, vol. XL, p. 1, July, 1920.
- ⁸ Meyer, H., and Ransom, F. *Arch. f. exper. Path. u. Pha.*, vol. XXXIX, p. 369, 1903.
- ⁹ Teale and Embleton. *Jour. Path. and Bact.*, vol. 1, p. 23, 1919.
- ¹⁰ Wamwright, J. M. *Arch. Surg.*, vol. XII, p. 1062, 1926.

CHRONIC TETANY
By HENRY J. JOHN, M.D.
OF CLEVELAND, OHIO
FROM THE CLEVELAND CLINIC

IN THIS paper I am applying the general term chronic tetany only to that form of tetany which occasionally develops after a thyroidectomy, and which is caused, presumably, by either a direct or an indirect injury to the parathyroids. Acute tetany sometimes develops shortly after a thyroidectomy, but clears up after a few days of treatment and does not reappear. Such cases are due, doubtless, to some temporary derangement of the parathyroid glands which is quickly overcome. When, however, such a derangement does not promptly right itself and attacks of tetany reappear periodically, the condition may properly be designated chronic tetany. Whether tetany is due to the actual removal of the parathyroid glands, or to some injury inflicted upon them during an operation, or whether it develops later as the result, perhaps, of a contraction of the connective tissue which interferes with the vitality of the gland, is immaterial, as far as the present discussion is concerned.

According to statistical data chronic tetany of the type we are considering is of rare occurrence, but when it does occur, it is a serious condition, and it is fortunate alike for the surgeon and for the sufferers from this complication of thyroidectomy, that thanks to Collip and his co-workers a means of combating tetany of this type has been discovered.

Among the factors which make the treatment of chronic tetany a complex problem is the very considerable psychic disturbance with which it is associated. It is very difficult to evaluate this psychic factor, to say nothing of eliminating it. Some patients with apparent tetany are purely neurotic and the "tetany" can be eliminated if they remain under observation for a long enough period and are properly controlled.

One of my patients, a neurotic bookkeeper, who was supposed to have chronic tetany, had been making the rounds of the local profession for several years before she was turned over to me for treatment. Considering at first that I was dealing with a bonafide case of tetany, I started the administration of Collip's parathormone, giving one cubic centimetre intravenously twice a week and checking the blood calcium content at the same time. However, when the blood calcium was between 11 and 13 mg per 100 c.c. of blood, my suspicion was aroused as to the true nature of the case, and I resorted to a subterfuge by substituting sterile saline solution for the parathormone. The relief of symptoms which followed the former was the same as that which followed the administration of the latter, while the blood calcium level remained unchanged. This patient is still going from one doctor to another, no doubt, and still receiving parathormone with apparently ideal results. Since the psychic factor in all cases of tetany must be considered, such a case

CHRONIC TETANY

as the one we have cited emphasizes the importance of a proper control of all cases. In the following discussion of cases of tetany I shall, therefore, emphasize the psychic phenomena which may be met and the difficulties which are encountered in their treatment.

It is not strange that the psychic phenomena form an important part of the clinical picture in cases of chronic tetany, for these patients have experienced severe attacks of tetany and therefore they dread their recurrence, nor is it surprising that at the slightest suggestion of a recurrence of the symptoms of tetany these patients rush to the doctor's office in the hope that he may be able to thwart the attack. It is the uncertainty of the outcome which breaks their spirit—the fear that they will never be free from these attacks. Not knowing when an attack may occur, they keep away from social gatherings, they are afraid to ride alone on a street car. Some have a chronic diarrhoea. Nevertheless, in most of these cases the classical attacks of tetany marked by carpopedal spasm, Chvostek sign, etc., are rather far apart. When the attacks do occur, they cannot be attributed to any special cause, but they apparently come out of a clear sky and in a few minutes develop to their full severity. Moreover—and the following fact complicates the picture—in these attacks the serum calcium content is not exceedingly low, as is the case in acute tetany. (See Protocols I and II.) There are alternating variations in the serum calcium data with which the symptoms do not correspond. Thus in some cases a patient may feel best when the serum calcium is low and may have an attack of tetany when the serum calcium is not far from the normal level.

Protocol I gives the data in a case of chronic tetany which began with acute tetany six days after a thyroidectomy, the serum calcium ranging from 7 to 13 mg per 100 c c. In this case the symptoms were relieved by repeated injections of parathormone. At certain periods this patient remained free from symptoms for a month without taking any parathormone, so that at one time I began to think that a cure was being established. I began to suspect that there might be a psychic element in this case when in August, 1925, the symptoms diminished progressively, although during this month the patient received but two doses of parathormone when her serum calcium was 9.5 and 10 mg per 100 c c, respectively. On September 3rd, 10th and 24th I administered normal saline intravenously without the knowledge of the patient. My suspicion of a psychic factor seemed confirmed when following these injections the symptoms always subsided. For a month and a half the patient continued to receive saline solution instead of parathormone without having a single attack of tetany and I began to think that the problem of this case was solved and that I would soon be able to tell the patient what I had done and to assure her that her attacks were due to fear and that by subduing the fear she would be permanently cured. She remained symptom-free for four and one-half months at the end of which time she had a slight attack and on March 5, 1926, she came to the Clinic with the most severe attack of tetany I have ever seen, although even then her serum calcium was 9 mg per 100 c c.

HENRY J JOHN

PROTOCOL I

CHRONIC TETANY

(Case No 132,065 Woman, thirty nine years of age Tetany first developed
October 28, 1924, six days after thyroidectomy)

Date	Parathormone units	Serum calcium mg per 100 c c							Notes
		7	8	9	10	11	12	13	
1925 Mar 20	5					11			
Apr 3	5						12		
6	5							13	Diuresis
7	7 5						12		Feels better
9	10					11			Feels better
10	10				10				Menstruating
14	7 5			9					Better
16	5		8 6						Not well
21	10		8 1						Not well
23	10		8 5						Feels fine
25	10			9					Feels fine
29	10			9 5					Feels fine
May 1	10		8 6						Muscle cramps
4	10			9					Well
6	10				10 5				Well
8	5					11			Menstruating
11	10				10				Fine
15	9 5				10				Fair
19	5				10				Very well
27	7 5					11 5			
29	5						12		
June 2	9					11 2			
5	6 5			9 5					
8	10					11 5			Menstruating
11	7					11			
16	10				10				Not well
(Went on a trip to California, took 10-20 units per week)									
July 28	10								Menstruating
Aug 3	10				10				Not well

CHRONIC TETANY

PROTOCOL I—Continued

CHRONIC TETANY

(Case No 132,065 Woman, thirty-nine years of age Tetany first developed October 28, 1924, six days after thyroidectomy)

Date	Parathormone units	Serum calcium mg per 100 c c							Notes
		7	8	9	10	11	12	13	
Aug 29	10			9 5					Menstruating
Sept 3	Saline					11			Not well Perfect relief after injection
10	Saline			9 7					Feels uncomfortable
24	Saline			9 5					Slight drawing of muscles around mouth
1926 Feb 16	10		8 5						Slight attack
20					10 5				
Mar 2	20		8						
5	40			9					Very severe attack of tetany, lasting an hour
6	20	7							Better
8	20		8 5						Better
9	40			9					Attack of tetany, less severe than above
10	20		8						Not well
11	20		8						Better
13	40				10				
18	20			9					Slight tightness of abdominal muscles
20	20			9 5					Well
22	12				10				Well
25	20		8 5						
29	16				10				Menstruating
Apr 5	20			9					Not well
14	20			9					Slight tingling of muscles
22	20				10 5				Slight dizziness
May 5 (Took 10 units parathormone at home when she thought an attack was approaching)	20						12		Malaise
June 5	40						12		Acute attack of tetanv
14	20				10				Slight tingling

HENRY J JOHN

PROTOCOL II

CHRONIC TETANY

(Case No 124,350 Woman thirty-four years of age Tetany first developed June 14, 1923,
two days after thyroidectomy)

Date	Parathor- mone units	Scrium calcium mg per 100 c c								Notes
		5	6	7	8	9	10	11		
1925 May 25						9			Feels wretched Muscle spasm	
27	5					9				
June 1	10				8				Much better	
4	10					9.4			Much better	
6	6						10		Much better	
9	6							11	Much better	
12	5			7					Much better	
16	4			7					Much better	
20	10					9			Much better	
24	10				8				Much better	
27	10				8				Much better	
30	6				8				Much better	
July 3	10			7					Much better	
7	10 (Had many severe attacks of tetany)				8				Better on the day of injec- tion	
1926 Jan 14	15		6						Severe attack night before	
16	20			7					Only slight relief	
18	15		6.5						Nervous	
Feb 13	20				8				Several acute attacks	
17	20		6.5						Attack day before	
18	20				8				Feels fine In hospital two days	
19	20		6.5						Feels fine In hospital	
20	10				8				Feels fine In hospital	
24	10			7					Feels fine In hospital	

CHRONIC TETANY

PROTOCOL II — *Continued*

CHRONIC TETANY

(Case No 124,350 Woman thirty-four years of age Tetany first developed June 14, 1923, two days after thyroidectomy)

Date	Parathormone units	Serum calcium mg per 100 c c							Notes
		5	6	7	8	9	10	11	
1926 Feb 27	20			7 5					Very weak
Mar 1	40	5 5							
2	40				8				
5	40				8				
6	20			7 5					Feels fine
8	40			7 5					Feels fine
9	10				8				Feels fine
10	20				8 5				Feels fine
11	40					9			Feels fine
12	40				8				Feels fine
13	40								Feels fine
15	20			7 5					Feels fine
16	40		6						Cramps
17	40			7 5					Better
18	40			7					
19	36			7					
20	40				8				
22	40				8				
23	40			7 5					
24	40			7 5					Better
25	40				8				
26	40								Tired Ultraviolet rays
27	40		6 5						Ultraviolet rays
30	40				8 5				
31	40			7 5					

HENRY J JOHN

PROTOCOL II—Continued

CHRONIC TETANY

(Case No 124,350 Woman thirty-four years of age Tetany first developed June 14, 1923,
two days after thyroidectomy)

Date	Parathor- mone units	Serum calcium mg per 100 c c								Notes
		5	6	7	8	9	10	11		
1926 Apr 1	40				8					
2	40				8 7		10			
3	40									
5	40						10			
6	40				8 5					
7	40					9				
8	40					9				
9	40					9				
10	40			7 5						
12	40						10			
13	40				8 5					
14	40				8 5				Tired	
15	40									
16	40					9				
17	40					9 5				
19	40					9 5				
20	40		6							
21	40				8 5					
22	40				8 5					
23	40				8 5					
24	40					9				
26	40									
27	30					9				
28	40				8 5				Feels fine	
29	40				8 5					
30	40				8 5				"No pep "	
May 3	40				8 5					
4	Saline				8 5				Feels fine	

CHRONIC TETANY

PROTOCOL II—Continued

CHRONIC TETANY

(Case No 124,350 Woman thirty-four years of age Tetany first developed June 14, 1923, two days after thyroidectomy)

Date	Parathormone units	Serum calcium mg per 100 c c							Notes
		5	6	7	8	9	10	11	
1926 May 5	Saline				8				Not well
6	40				8				
7	Saline			7					
8	Saline				8 5				Feels fine
10	Saline						10		Tingling of fingers Not well
11	Saline			7 5					Tingling of fingers Not well
12	Saline				8				Saline relieves tingling Well
13	Saline					9			Feels fine
14	Saline					9			Feels fine
15	Saline				8 5				Feels fine
17	Saline				8 5				Feels fine
18	Saline				8 5				Feels fine
19	Saline				8 5				Feels fine
20	Saline				8 5				Feels fine
21	Saline				8 5				Feels fine
22	Saline				8 5				Very well
24	Saline				8 5				Not well
26	Saline				8 5				Well
29	Saline				8				Well
June 1	Saline				8 5				Well
3	Saline				8 5				Well
5	Saline			7 5					Well
7	Saline				8				Feels fine
8	Saline				8 5				Feels fine
12	Saline				8				Feels fine
14	Saline				8				Slight twitching of muscles of right eye

Forty units of parathormone were administered intravenously, but it was a full hour before she was able to relax. After this occurrence, in spite of the serum calcium content, there was no doubt in my mind that we were dealing with a case of true tetany. Since that time the patient has been receiving parathormone at irregular intervals and is now taking it at home. When on June 5, 1926, she had her last attack of tetany, which was a severe one, her serum calcium was 12 mg per 100 c c.

The data concerning another case of chronic tetany are given in Protocol II. This patient, an Italian woman thirty-four years of age, developed acute tetany two days after a thyroidectomy. Her serum calcium fluctuated from 5.5 to 11 mg per 100 c c. She had been under steady treatment with parathormone for one and one-half months in 1925 (May to June), when her improvement became so marked that I asked her not to come for treatment unless her symptoms reappeared. She apparently did not understand me, for I did not see her again for six months and thought that she was remaining free from attacks. On January 14, 1926, however, she returned so weak and exhausted that she had to be carried into the Clinic. She reported that she had had many attacks during the preceding six months and was taking calcium lactate by mouth. Marked improvement followed when the parathormone medication was resumed and the patient insisted on coming in daily. Her average serum calcium was about 8 mg per 100 c c with few variations in either direction. On May 9, 1926, I resorted to the use of normal saline instead of parathormone and have continued to use this up to the present writing (August, 1926). The patient has felt well, has had no attacks of tetany and there has been no appreciable change in the serum calcium level. Whether or not tetany will again develop as in the preceding case cannot, of course, be predicted.

It would appear that although, as these cases indicate, a psychic factor is present in certain cases of chronic tetany, nevertheless since it is impossible to know whether or not a true attack may develop, it is necessary to administer parathormone extract to these patients more or less continuously. The administration of parathormone extract is followed by relief in all cases. False attacks due to the psychic factor, however, are equally well relieved by the injection of saline solution.

In the literature the chief stress has been placed upon the rôle of the parathyroid glands in the metabolism of calcium. Nevertheless, I cannot but feel that faulty calcium metabolism represents only a part of the actual problem with which we are dealing in these cases of chronic tetany. I have repeatedly seen patients with chronic tetany who felt quite well when the serum calcium was 7 or 8 mg per 100 c c while these same patients have complained of much discomfort when the serum calcium was 11 or 11.5 mg per 100 c c. Thus the patient whose history is cited above felt well when her serum calcium was 7 or 8 mg. per 100 c c, while the most severe attack developed when the blood calcium was 9 mg per 100 c c. It is hard, therefore, to believe that the serum calcium can be a direct index to the severity of the

condition. I believe, rather, that the calcium content of the blood represents but a part of the complex picture presented by this disease.

In an attempt to secure some light on this complex problem, I have made a study of the literature and have reviewed my own series of cases of parathyroprival tetany. A brief résumé of the findings in these studies will be given here.

All authors agree that in parathyroprival tetany a low calcium content of the blood is found. Attempts to remedy this condition by the oral supply of calcium, however, have never been successful, showing that the primary cause of tetany is not a reduction in the amount of calcium in the circulation, but rather a disturbance of the mechanism for its proper utilization. Thus, Denis and Corley² found that the tissues of rabbits which had received a daily dose of calcium chloride or calcium lactate failed to show a higher calcium content than did the tissues of the control animals. These investigators found also that daily exposure to ultra-violet rays from a mercury tungsten arc had no effect on the calcium content of the tissues or serum.

SWINGLE and RHINOLD³ exposed animals with tetany to ultra-violet radiation with the same results, that is, they found no change in the calcium content of the blood serum. They did find, however, that radiation greatly prolonged the life of the parathyroidectomized animals and brought about a striking amelioration of the violent symptoms.

According to SWINGLE and WENNER⁴ the withdrawal of a considerable quantity of blood from dogs suffering from parathyroprival tetany temporarily relieved the symptoms and induced a marked rise in the level of the serum calcium, the symptoms disappearing as the serum calcium rose. This beneficial effect lasted from ten to twelve hours, after which the tetany returned.

GREENWALD⁵ administered calcium salts to thyroparathyroidectomized dogs and found first that a large part of the calcium was deposited in the tissues, chiefly as calcium phosphate, while later a calcium equilibrium was established. In a parathyroidectomized dog which had received a liberal supply of calcium, there was a normal concentration of calcium in the serum and the animal was as resistant to the administration of sodium phosphate (50 mg of phosphorus per kilogram of body weight) as were normal dogs. Later, when the supply of calcium was diminished, the concentration of the calcium in the serum was also diminished and the injection of the same amount of sodium phosphate was followed by tetany.

WEST⁶ gives the following figures for the forms in which calcium occurs in normal individuals:

Total calcium	.	.	12.4 mg per 100 c.c. of blood serum
Ionizable calcium	.	.	9.0 mg per 100 c.c. of blood serum
Colloidal calcium	.	.	3.4 mg per 100 c.c. of blood serum

For the maintenance of the calcium equilibrium in a healthy man accustomed to ordinary diet, 0.7 gram calcium oxid per day seems to be the minimum requirement. However, during the period of bone formation and growth the need of an abundance of calcium is obvious.

The weakening of the bones and teeth which is said to be a common accompaniment of pregnancy and of lactation is largely due to a preventable withdrawal of lime from these structures.

When other forms of food are substituted for mother's milk, the calcium intake is more likely to be deficient than any other inorganic element. To cover the need of calcium, foods which are high in calcium content should be chosen.

In a personal communication to the author an obstetrician made the following statement "I give always plenty of milk daily to a pregnant woman, and I find that by this I can more than save on dentist bills the cost of the milk"

Table I shows how greatly the calcium content of different foodstuffs varies. Milk contains so much calcium that only enough to yield 400 calories is required to supply one gram of lime, while the calcium content of round steak and white bread is so low that enough to yield 10,000 calories would be required to supply the same amount of lime.

ANDERSON⁶ found an average of 10.7 mg of calcium per 100 cc of blood serum in patients under forty-five years of age and 10.4 mg per 100 cc in persons above this age. His work included a study of 38 patients with normal blood findings. The actual range

TABLE I
Calcium Content in Different Foodstuffs (After Sherman)

Foodstuffs in order of calcium content	Calcium oxide per 100 gms of edible substance	Foodstuffs in order of calcium content	Calcium oxide per 100 gms of edible substance
Almonds	0.30	Oranges	0.06
Beans, dried	0.22	Prunes, dried	0.06
Egg yolk	0.20	Wheat, entire grain	0.06
Milk	0.17	Low grade flour	0.04
Pears, dried	0.14	Beets	0.03
Oatmeal	0.13	Potatoes	0.02
Walnuts	0.11	Pineapple	0.02
Peanuts	0.10	Bananas	0.01
Parsnips	0.09	Rice, polished	0.01
Turnips	0.09	Beef, all lean	0.01
Eggs	0.09	Patent flour	0.025
Carrots	0.08	Apples	0.014

was from 10 to 11.5 mg of calcium per 100 cc of blood serum, and these findings did not vary on repeated examinations of the same subject except during menstruation, when the serum calcium was always increased by about one mg. In patients with renal insufficiency the calcium values were often lower, but this was not a constant finding. In cases of hypertension without renal symptoms, the calcium values were within or but slightly above the normal range. In cases of asthma they were lower, and also in cases of hyperthyroidism. Among four patients with cancer the calcium values were subnormal in two cases and normal in the other two, while in one case of metastatic cancer in the bones it was especially high, viz., 21.8 mg per 100 cc.

TEPLITZ⁷ found that there is a decided loss of calcium from the blood in the terminal stages of pulmonary tuberculosis.

FEINBERG and LASH⁸ made studies of the blood calcium in cases of eclampsia and found no appreciable variations, although they state that on theoretical grounds a decrease in serum calcium would be expected.

In diabetic patients the potassium-calcium ratio is usually high. Kylin⁹ found a high calcium value and a low potassium-calcium ratio in only one of his diabetic patients.

According to LESNE and TURPIN¹⁰ the spasm of tetany seems to be a syndrome in which an exaggerated neuromuscular excitability is combined with transient humoral changes. The chronaxia in the nerve and the muscle shows that the changes are similar to those induced by vasomotor disturbances due to chilling or to brief intoxication. These authors state that in these patients the reduction of calcium ions appears to be associated with disturbances of the acid-base balance of the plasma. This syndrome corresponds to that described by Bigwood¹¹ as present in epilepsy. It is probable that the acid-base imbalance affects not only the nervous system, but also tissues of ectodermal origin. The functioning of organs which control the carbohydrate or protein metabolism may also be involved.

The theories which ascribe spasmophilia to the parathyroids, to the action of toxins, or to an excess or deficit of calcium, do not necessarily conflict, but the theory that it is due to a lack of calcium ions seems to have the most secure foundation of them all

MACCIOTTA²² studied the relationship of the thymus to tetany. He removed the thymus gland in one dog and in ten young rabbits, of which five survived. No tetany was produced, but on the other hand the calcium and magnesium concentration in the plasma rose, while their concentration in the tissues was lowered. From this he argues that a hyperfunction of the thymus might be one of the factors in tetany. The removal of parathyroids in his animals produced a fatal tetany.

KUROKAWA²³ has made extensive histological studies of normal and of pathological human parathyroid glands which are of such importance that it seems well to review them in some detail. Eight hundred and fifteen parathyroid glands from two hundred and forty human subjects, ranging in age from late fetal to eighty years, were studied. It was found that anatomically the parathyroids become larger with advancing years, their development being most marked at the period of adolescence. During fetal life the parenchyma cells are composed only of clear chief cells, but these cells begin to decrease in number at about the period of adolescence, and the dark cells begin to appear, in the adult the dark chief cells predominate. The clear chief cells contain a large quantity of glycogen, but no fatty substance, the dark chief cells contain a large quantity of fatty substance instead of glycogen, consequently the quantity of glycogen or of fatty substance is influenced by the number of each type of the chief cells. The oxyphils begin to appear at about the period of adolescence and tend to increase in number. These cells never contain more than a trace of glycogen or fatty substance. The time of appearance and the number of follicles and of colloidal formations are about the same as in the case of the oxyphils. The time of appearance of quantitative fluctuation of the dark chief cells and of the oxyphils coincides with the time when the development of the parathyroids is most marked, i.e., the period of adolescence. The oxyphils are larger than the chief cells and contain an abundance of stainable substances. The protoplasm and nuclei do not show any degenerative changes. The appearance of, or the increase in the oxyphils, is not accompanied with an increase of intercellular tissue, which may be regarded as an atrophic change. The oxyphils increase in number with advancing age, but this increase does not represent a senile change. The oxyphils appear in masses and often form nodules, some of which may be seen with the naked eye. The oxyphils appear at the time when the clear chief cells begin to decrease and the dark chief cells to increase, and they increase in number during pregnancy. These facts indicate that the oxyphils have some important function.

In status lymphaticus, lipomatosis and atrophy of the parenchyma with marked increase of the oxyphils occur. In beriberi in adults there is a marked increase of the clear chief cells. In infants the clear chief cells are hypertrophic. In chronic tuberculosis the increase of intercellular connective tissue is very marked (cirrhosis). In syphilis the picture is about the same as in cirrhosis. In cases of new growths as a rule the oxyphils are increased. In pregnancy also the oxyphils are increased. In sarcoma of bones, marked follicular formations are found.

HJORT, GRUNZIT and FLINGER²⁴ analyzed desiccated specimens of the parathyroids, the pituitary gland, the thymus gland and the ovaries of the ox, calf and hog, and found the iodine content of the parathyroids to be no greater than that of the other glands. The iodine found in these glands probably represents the normal distribution of the substance throughout the body tissues.

Interesting and valuable as are the findings and conclusions of the authors cited above, of especial interest in view of our own observations are the reports of various investigators regarding the relation of parathyroprival

tetany to calcium metabolism. The fact that the blood calcium in cases of tetany is decreased has been demonstrated by the work of the following authors: Berman, Lissner and Shepardson,¹⁶ Snell,¹⁷ Collip,¹⁸ Cameron,¹⁹ Fisher,²⁰ Hjort,²¹ and Sherrill and Copp.²²

GROVE and VINLS²³ consider that the essential physiological roles of the parathyroid glands are (1) a specific action on calcium metabolism, and (2) a generalized stimulating effect on body metabolism as a whole. They emphasize especially the role of the

PROTOCOL III

Reaction of Normal Individual to the Injection of Parathormone (The Author—July 28, 1925)

Time	Serum calcium mg per 100 c c	Amount of parathormone injected	Symptoms
9 30 A M	10.5	5 units	Tinnitus aurium Tingling fingers, headache, chill until 4 P M.
10 00 A M			
10 40 A M			
11 40 A M	3.5	5 units	The above symptoms not increased by the second dose
4 15 P M	12		All symptoms gone

parathyroids in the fight against chronic infections, not by specific action on the infecting organisms, but by action on the tissue cells whereby the most favorable conditions for an adequate resistance is produced. Among the factors concerned in this process, the maintenance of proper calcium balance in the plasma is important. The majority of chronic diseases are due to the protracted absorption of toxic substances from a septic

PROTOCOL IV

Reaction of Normal Individual to the Injection of Parathormone (The Author—May 4, 1926)

Time	Serum calcium mg per 100 c c	Amount of parathormone injected	Symptoms
9 00 A M	11	20 units	Headache Pain in joints, nervousness, slight chill Pain in joints increased and quite severe Pain in joints increased, aching all over Chill
9 30 A M			
10 15 A M			
11 00 A M	11.5		Chill decreasing, temperature 100
11 45 A M			
12-2 P M	11.5		Well
2 00 P M			
2 20 P M	12		Well
2 45 P M			
4 45 P M			

focus and such absorption is accompanied by a decrease in the ionic calcium in the blood, the parathyroid glands being the regulators of this calcium metabolism.

CAMERON and MOORHOUSE²⁴ consider that the direct cause of parathyroid tetany is a slight diminution (1-2 mg per 100 c c) in the inorganic calcium of the plasma, which results indirectly from a diminution of the organic compounds. These authors suggest that the constancy of the blood calcium content depends on the slightly dissociable organic calcium compound which through a series of interlocked equilibria holds a definite amount of inorganic calcium in the plasma.

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In his presidential address before the Clinical Congress of the American College of Surgeons in New York, October 20, 1924, CHARLES H MAYO²⁵ made the following statement "The loss of parathyroids leads to great elimination of calcium by the urine and by the intestines, and when the percentage of calcium is reduced below 7 milligrams for each 100 cubic centimetres of blood tetany supervenes, and guanidin toxins are found in the blood"

In our series repeated estimations of the serum calcium in normal individuals showed the calcium content to lie between 10.5 and 11 mg per 100 c c

PROTOCOL V

*Reaction of Normal Individual to the Injection of Parathormone
(Dr P—May 4, 1926)*

Time	Serum calcium mg per 100 c c	Amount of parathormone injected	Symptoms
9 00 A M	11	20 units	Slight reaction, slight pain in joints
11 00 A M	12		
12-12 30			
2 00 P M	12		
4 45 P M	13		

of blood serum In definite cases of tetany the serum calcium ran as low as 4.5 mg per 100 c c and in chronic tetany it was usually 8 mg per 100 c c. or above

The calcium estimations here reported were made by the Tisdall method as described by Clark and Collip²⁶

Shortly after the use of parathormone was introduced, I noted that

PROTOCOL VI

Effect of Parathormone on Serum Calcium

*(Case No 149,261 Woman, thirty-eight years of age Tetany first developed March 3, 1926,
four days after thyroidectomy)*

Time	Serum calcium mg per 100 c c	Parathormone units
April 3, 1926		
8 00 A M	5.5	10
11 30 A M	4.5	10
1 30 P M	5	10
3 30 P M	4.5	10
5 30 P M	6	10

patients with chronic tetany would occasionally complain of a slight reaction after its administration which consisted in a feeling of depression and malaise, accompanied by pains in the joints In these cases the serum calcium as estimated daily or every few days did not rise appreciably but rather maintained a fairly constant level between 9 and 10 mg per 100 c c Because of these observations I was anxious to see what relation the variations in the serum calcium level from hour to hour after the administration of parathormone bore to the reaction Therefore, on July 28, 1925, after estimating the calcium content of my own blood serum, which proved to be 10.5 mg per

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100 c c, I took five units of parathormone intravenously. Within half an hour I began to hear ringing in the ears, which increased in intensity, and in forty minutes I felt a tingling in my fingers and had a severe headache, which was followed by a slight chill, which was not severe but lasted for several hours. The symptoms were much like those which are associated with the onset of a severe cold or with the reaction which follows the administration of a typhoid vaccine to one who is quite sensitive to it. An hour and

PROTOCOL VII

Effect of Parathormone on Serum Calcium

(Case No 157,614 Girl, seventeen years of age Tetany first developed March 23, 1926, five weeks after thyroidectomy)

Time		Serum calcium mg per 100 c c	Parathormone units
April 1, 1926	11 00 A M	7	10
	1 00 P M	7 5	10
	3 00 P M	9	10
April 6, 1926	8 00 A M	6 5	10
	10 00 A M	7 5	10
	12 00 M	7 5	10
	2 00 P M	7 5	10

ten minutes after the injection the serum calcium rose to 11 5 mg per 100 c c and two hours and ten minutes after the injection, when the symptoms were most severe and I was obliged to lie down, the serum calcium was only 3 5 mg per 100 c c. Naturally, I did not know what my serum calcium content

PROTOCOL VIII

The Effect of Parathormone and of Calcium Chloride on Serum Calcium

(Case 142,621 Woman thirty one years of age Tetany first developed January 22, 1925, three days after thyroidectomy)

Time	Calcium chloride intravenously	Serum calcium mg per 100 c c	Time	Parathormone units	Serum calcium mg per 100 c c
Jan 25, 1925	6 c c	3 5	June 30, 1925	10	5 5
8 00 A M			9 00 A M		5 5
10 50 A M			10 10 A M		5 5
11 50 A M			11 10 A M		4
12 50 P M			12 10 P M		5 5
2 50 P M			1 10 P M		6
4 50 P M			3 10 P M		7 5
6 50 P M			7 10 P M		5 5
		9	8 10 P M		

was at that time, and wanting to make sure whether or not my symptoms were actually due to the parathormone, I took five more units intravenously. The symptoms were not augmented after the second dose, but gradually became less and less, and in a few hours subsided entirely. I had to lie down for about two hours, but during the rest of the time I carried on my work. At 4 15 P M, six and three-fourths hours after the first and four and three-fourths hours after the second dose, the serum calcium was 12 mg per 100 c c.

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Thus after a primary rise of serum calcium there was a marked drop for which I am unable to account, this in time being followed by a rise to 12 mg per 100 c c (Protocol III)

The findings in this experiment, and a mass of data accumulated by estimations of the serum calcium in patients, were not sufficient to explain the observed phenomena and I, therefore, nine months later, on May 4, 1926, administered to myself 20 units of parathormone intravenously. (Protocol IV) The serum calcium did not fall as in the first experiment, but I did experience a very severe reaction which started with pains all over the body, especially in the joints, a severe headache which was followed by a chill, in which my temperature rose to 100° F All the symptoms disappeared in five

PROTOCOL IX

The Effect of Intravenous Injection of Calcium Chloride on Blood Calcium

(Case No 142,621 Woman thirty-one years of age Tetany first developed after thyroidectomy)

Time	8 00*	10 50	11 50	12 50	2 50	4 50	6 50
Bl cal mg per 100 c c	3 5	6 0	7 5	6 0	5 5	5 5	9 0

* 5 c c 10 per cent CaCl₂ intravenously

hours, but the chill was so severe that I was obliged to spend several hours in bed under blankets and with hot water bottles

On the day on which I carried out this second experiment, an identical test was made on one of my colleagues, the same dosage of parathormone being used The results of this test are shown in Protocol V In this case also there was no fall in the blood calcium The subject experienced a reaction, but it was very mild and lasted for only half an hour

These three observations show that in normal individuals the serum calcium is increased after the administration of parathormone That this is true in cases of tetany also is shown by Protocols VI, VII and VIII, although as one would expect, the increase is not as stable as in normal individuals The effect of the intravenous injection of calcium chloride on the serum calcium is shown in Protocol VIII

CONCLUSION

1 From the literature and from personal observations and experiments we may draw the conclusion that parathyroprival tetany is due to a disturbance of the mechanism which governs the metabolism of calcium

2 Parathormone appears to supply the essential element for the operation of this mechanism

3 The series of cases of chronic tetany which have come under my observation show a serum calcium content of not less than 8 mg per 100 c c up, while in acute tetany the lowest figure has been 4 5 mg per 100 c c The normal range of serum calcium appears to lie between 10 5 and 11 mg. per 100 c c

4 Following the administration of parthormone there is an alleviation of symptoms and the calcium in the blood rises, although there is an alternating variation during the first few hours after its administration. The administration of parathormone to normal individuals results in a rise in the serum calcium content, accompanied by a reaction which may be quite severe, as in my own case. The symptoms of this reaction are similar to those which accompany the onset of an acute cold, viz., headache, pains all over the body, pains in the joints, chill and fever.

5 While the symptoms of chronic tetany are relieved promptly by the administration of parathormone, in some instances they are relieved as promptly by the administration of normal saline, a fact which leads one to believe that there is a psychological factor in certain cases. It is therefore important for both the physician and the patient to attempt to find some criterion whereby to differentiate the onset of "false attacks" from "true attacks."

NOTE—I wish to express my acknowledgment to Eli Lilly and Company for the liberal supply of parathormone which was used in this work.

REFERENCES

- ¹ Denis, W, and Corley, R. C. Effect of Excessive Calcium Ingestion on Calcium Content of Tissues With and Without Application of Ultra-violet Light. *J Biol Chem*, 1925, vol lxvi, pp 609-617.
- ² Swingle, W. W., and Rhinhold, J. G. Effect of Ultra-violet Radiation Upon Experimental Tetany. *Am J Physiol*, 1925, vol lxxv, pp 59-69.
- ³ Swingle, W. W., and Wenner, W. F. Effect of Bleeding Upon Serum Calcium of Thyroparathyroidectomized Dogs. *Am J Physiol*, 1926, vol lxxv, pp 372-377.
- ⁴ Greenwald, I. Effect of Administration of Calcium Salts and of Sodium Phosphate Upon Calcium and Phosphorus Metabolism of Thyroparathyroidectomized Dogs, With Consideration of Nature of Calcium Compounds of Blood and Their Relation to Pathogenesis of Tetany. *J Biol Chem*, 1926, vol lxxvii, pp 1-28.
- ⁵ West, F., Bauer, J., and Barnickol, K. Determination of Calcium and Thrombin in Serum. *J A M A*, 1922, vol lxxviii, pp 1041-1043.
- ⁶ Anderson, W. T. Some Reseaches on Calcium Content of Serum. *Hospitalstid*, 1925, vol lxxviii, pp 1177-1193.
- ⁷ Teplitz, M. M. Effect of Oral Administration of Calcium Lactate and Thyroid Extract on Calcium Content of Blood Serum in Pulmonary Tuberculosis. *Am Rev Tuberc*, 1925, vol xii, pp 222-227.
- ⁸ Feinberg, S. M., and Lash, A. F. Blood Calcium in Eclampsia. *Surg, Gynec and Obst*, 1926, vol xlii, pp 255-258.
- ⁹ Kylin, E. Blood Calcium in Diabetes. *Zentralbl f inn Med*, 1926, vol xlvii, pp 79-80.
- ¹⁰ Lesne, E., and Turpin, R. Recent Clinical and Physiopathogenic Data on Spasmodophilia. *Presse méd*, 1926, vol xxxiv, pp 1-3.
- ¹¹ Bigwood, E. J. Blood Calcium Deficiency in Epileptics. *Compt rend Soc. de biol*, 1924, vol xc, pp 98-100. Physical and Chemical Balance in Blood in Epilepsy, Calcium Ion. *J de physiol et de path gen*, 1924, vol xxii, pp 70-78, 94-108.
- ¹² Macciotta, G. Function of Thymus in Pathogeneses of Tetany. *Policlinico*, 1925, vol xxxii, pp 589-606, abs *J A M A*, 1926, vol lxxxvi, p 382.
- ¹³ Kurokawa, K. Histological Studies of Normal and Pathological Human Parathyroid Glands. *Japan M World*, 1925, vol v, pp 241-251.
- ¹⁴ Hjort, A. M., Gruhzit, O. M., and Flieger, A. G. Parathyroid Glands and Their Iodine Content. *J Lab and Clin Med*, 1925, vol x, pp 979-984.

CHRONIC TETANY

- ¹⁶ Berman, L. Effect of Protein-free Acid-alcohol Extract of Parathyroid Glands Upon Calcium Content of Blood and Electrical Irritability of Nerves of Parathyroidectomized and Normal Animals. *Am J Physiol*, 1926, vol lxxv, pp 358-365
- ¹⁷ Lissner, H., and Shepardson, H. C. Tetania Parathyreopriva Treated With Collip's Parathyroid Extract. *Endocrinology*, 1925, vol ix, pp 383-396
- ¹⁸ Snell, A. M. Parathyroid Extract in Treatment of a Case of Tetany. *J A M A*, 1925, vol lxxxv, pp 1632-1633
- ¹⁹ Collip, J. B., and Clark, E. P. Further Studies on Physiological Action of Parathyroid Hormone. *J Biol Chem*, 1925, vol lxxiv, pp 485-507. The Internal Secretion of the Parathyroid Glands. *Proc Nat Acad Sc.*, 1925, vol xi, p 484. A Parathyroid Hormone and its Physiological Action. *Am J Physiol*, 1925, vol lxxii, No 1, pp 182-183
- ²⁰ Cameron, A. T., and Moorhouse, V. H. K. The Action of Collip's Parathyroid Extract in Blood and Cerebral Spinal Fluid Calcium. *Trans Royal Soc, Montreal*, 1925, vol xix, pp 29-43
- ²¹ Fisher, N. F., and Larson, E. Effects Produced by Extracts of Parathyroid Glands on Normal and Parathyroidectomized Dogs. *Am J. Physiol*, 1925, vol lxxv, pp 93-106
- ²² Hjort, A. M., Robinson, S. C., and Tendick, F. H. Extract Obtained from External Bovine Parathyroid Glands Capable of Inducing Hypercalcemia in Normal and Thyreoparathyroprivic dogs. *J Biol Chem*, 1925, vol lxxv, pp 117-128
- ²³ Sherrill, J. W., and Copp, E. F. F. Changes in Blood Serum Calcium Following Administration of Parathyroid Extract. *California and West Med*, 1926, vol xxiv, pp 183-188
- ²⁴ Grove, W. R., and Vines, H. W. C. Calcium Deficiencies. Their Treatment by Parathyroid. *Brit M J*, 1922, vol i, pp 791-795
- ²⁵ Cameron, A. T., and Moorhouse, V. H. K. Tetany of Parathyroid Deficiency and Calcium of Blood and Cerebrospinal Fluid. *J Biol Chem*, 1925, vol lxxii, pp 687-720
- ²⁶ Mayo, Chas. H. Calcium. *Surg, Gynec and Obst*, June, 1925, vol xl, pp 822-825
- ²⁷ Clark, E. P., and Collip, J. B. Tisdall Method for Determination of Blood Serum Calcium With a Suggested Modification. *J Biol Chem*, 1925, vol lxxii, pp 461-464

THE PRINCIPLES UNDERLYING THE RATIONAL TREATMENT OF ACUTE OSTEOMYELITIS

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IN A previous communication the mechanism of acute osteomyelitis was described. The essential parts of this mechanism, which was minutely described, include (1) A bacteriæmia or general blood infection, (2) a fixation point in the vascular network of a bone (thrombo-embolic phenomenon), (3) the development of a pathological process characterized by a thrombo-arteritis or thrombo-phlebitis, and (4) necrosis of bone cells and tissue. These four factors were found to be able to explain fully every type of pathology and of clinical fact that occurs with acute osteomyelitis.

In a second communication the roentgenographic appearances of acute osteomyelitis were correlated with the anatomical, pathological and clinical facts of this disease. The following classification could be established:

1 A group of cases of subperiosteal abscesses which are based on a superficial acute osteomyelitis in the cortex of a bone of slight grade and extent.

2 A group of cases of acute osteomyelitis in which the main stem of the nutrient artery forms the fixation point and becomes occluded by the thrombo-embolic process and in which as a consequence the entire diaphysis becomes involved in the pathological process, maximum lesions occur. This group is recognized roentgenographically by the sequestration of the entire diaphysis of the bone.

3 A group of cases of acute osteomyelitis in which one of the primary divisions of the nutrient artery is caught in the thrombus-embolus formation. These are recognized roentgenographically as well as during operation when the involvement of the shaft of the bone occurs through the entire thickness of the shaft at one end of the diaphysis approximately to one or the other side of the point of entrance of the trunk of the nutrient artery. Such cases are easily recognizable in the X-ray photographs.

4 A group of cases of acute osteomyelitis in which the thrombus-embolus formation occupies one of the secondary branches of the nutrient artery. These are recognized roentgenographically and during operation when the involvement of the diaphysis does not extend throughout the thickness of the shaft of the bone. These seemingly follow no rule in their development, are of irregular size and shape, frequently correspond to a thin shell of the cortex of the bone, occupy only a relatively small segment of the circumference of the bone and depend for their physical characteristics and roentgenographic appearances upon the position of the secondary branch, its importance in the intraosseous vascular network, and upon the possibilities of collateral circulation.

TREATMENT OF ACUTE OSTEOMYELITIS

5 A group of cases of acute osteomyelitis in which the thrombo-embolic lesion is caught in the terminal part of an end vessel of the intraosseous vascular network. The roentgenological appearances of the finished lesion is that of a cavity in the bone (Brodie abscess)

These five groupings are typical of sharply demarcated lesions differentiated from one another by the location of the fixation point in the intraosseous vascular tree and based upon the consequence of the thrombo-embolic and thrombo-phlebitic process which forms the pathologic basis of all cases of acute osteomyelitis and of the consequent necrosis which occurs. These are recognizable in the roentgenographic evidences. Very frequently sharply demarcated lesions are not recognizable and these atypical and unclassifiable pictures depend upon two essential factors which are as follows

A The occurrences of cases of acute osteomyelitis in which more than one fixation point are formed either simultaneously or subsequently to one another, within the confines of a single bone, at each of which a typical thrombo-phlebitic lesion develops independently of the others. In the early stages of such a multiple pathological formation the lesions are distinct from one another and the roentgenographic appearances follow along the lines described in the previous five typical groupings. No further progression may occur. In many of the cases, however, the consequences of the initial thrombo-phlebitic lesion involve such an extensive part of the bone, that the several foci overlap one another primarily or coalesce subsequently at their peripheries and a fusion occurs of more than one lesion; a large atypical area of bone thus becomes involved. In such cases the individual foci lose their identity in the roentgenographic pictures and their nature can only be surmised.

B The previously described conditions represent the end results of an uncomplicated initial lesion. Other changes and modifications of these underlying and essential anatomical and pathological facts and conditions are encountered in clinical, bedside and operating room observations, there are directly due to (1) the spreading characteristics of thrombo-phlebitic lesion in osseous tissue, (2) to the mutilations of the bone which necessarily accompany any osteotomy, (3) to combinations of both of these complicating factors, and (4) to exacerbations of infection of endogenous and exogenous origin. The various ways in which a thrombo-phlebitic lesion in bone (osteomyelitis) can spread, the directions which these various spreadings take place, and the consequences of the spreading of the essential thrombo-phlebitis or thrombo-arteritis of bone tissue with its resultant necroses have been minutely described on several previous occasions and will not be repeated here. Under these conditions the roentgenographic evidences lose their demarcating characteristics and atypical pictures result which are not possible of classification.

With these fundamental facts in mind it becomes apparent that in the treatment of acute osteomyelitis one has a twofold object to accomplish. (1) The treatment of the general infection (bacteriæmia—general blood infection as previously defined), and (2) the treatment of the local lesion.

TREATMENT OF THE BACTERIÆMIA

In any case a relative quantitative estimation of the magnitude of the infection can be established according to the number of colonies of bacteria which appear on the plate (plate culture method) in proportion to the amount of blood used to inoculate the culture medium in the plate. Thus, 1 or 5 colonies of bacteria per one cubic centimetre of blood as compared with 100, or an uncountable number of colonies of bacteria per one cubic centimetre of blood. This is a very rough method and is not strictly accurate, but for practical purposes the inaccuracy is inconsequential.

In practice the presence, or absence of a bacteriæmia or general blood infection, yield the following clinical groupings and the correct interpretation of the bacteriæmia in its relation to the clinical manifestations yield certain therapeutic indications.

A Treatment of the general infection is many times not called for as, commonly, the natural protective agencies of the body are able to nullify the bacteriæmia and its effects. Many times, unless one understands the essential nature of the pathological process involved in the development of a focus of osteomyelitis, the question of the bacteriæmia does not enter into therapeutic consideration, this is so because as pointed out on previous occasions the bacteriæmia through which the focus of osteomyelitis was caused to develop was a temporary phenomena and sufficient time had elapsed between its appearance and the moment of observation to allow for its spontaneous disappearance. Under these circumstances there are no clinical or laboratory evidences of its existence. Good prognoses should be the rule under these circumstances. A reservation should, however, be made in one's mind to cover those cases of acute osteomyelitis in which for some undefinable reason as explained previously the thrombo-phlebitis begins to spread, in these positive blood cultures may later be obtained and the character of the illness changes entirely for the worse.

B At the opposite end of the picture are those fulminating, progressive and severe forms of bacteriæmia and general blood infection, the existence of which is associated clinically with a symptom complex in which the local focus of osteomyelitis is of minor and secondary consideration and in which the bacteriæmia or general blood infection is the dominating factor in the entire clinical picture. Large numbers of viable organisms are demonstrable in the blood cultivations in such severe cases. The local focus may exhibit definite signs of its presence, or may be unrecognizable and undemonstrable owing either to the paucity of its clinical manifestations or to the profound intoxication produced by the general blood infection.

Any kind of local condition may be associated with such general blood infection. It is to be assumed under such conditions that large numbers of viable organisms are being discharged into the blood stream from the thrombo-phlebitic lesion and that the bacteria are multiplying in the blood also, the prognosis must therefore be a very serious one. The usual course of affairs includes a steady progression of the general blood infection until a

fatality occurs. Under these circumstances treatment directed to the local lesion is futile and fatalities are the rule and not the exception. One must understand that here one is dealing with cases of general blood infection and any treatment which is possible and permissible must be directed to the general infection; the local lesion plays a minor rôle. The premise that operation on the focus of osteomyelitis "furnishes to the unfortunate patient his only chance" is sometimes something which may not be refused in the presence of anxious parents and relatives; but whenever such earnest desires are acceded to, it should be unequivocally emphasized that the "chances" are practically nil. In the fulminating cases the entire duration of the illness is most often a question of a few days.

There are other somewhat less severe forms of acute osteomyelitis in which the blood contains large numbers of viable organisms, but in which the clinical picture does not carry with it that comparatively sudden overwhelming of the body with a profound toxæmia. Following operation there is little or no lessening in the magnitude of the bacteriæmia or, possibly, an increase in the latter. Under these circumstances the question of amputation should be discussed when the local conditions lend themselves thereto.

C. In between the mild cases of group *A* and the very severe cases of group *C* there exist large numbers of cases of acute osteomyelitis in which (1) there are well-marked evidences of one or more foci of acute osteomyelitis and (2) a demonstrable bacteriæmia.

Blood cultures obtained under these circumstances can be employed (*a*) in appropriate cases as an additional means of differential diagnosis, (*b*) as means by which the severity of the infection can be gauged, (*c*) as a help in estimating the prognosis, (*d*) as criteria upon which to base the primary or further operative treatment.

Occasionally the character of the organism demonstrated in the blood culture can be employed as a differential point in diagnosis. Cases are constantly being seen in which it is difficult to decide whether the localization has occurred in a bone or in a neighboring joint. True enough this sometimes indicates a simultaneous involvement of both, but in other cases the localization is hidden in a general inflammatory reaction. Under these circumstances the demonstration of organisms of the staphylococcus group—*staphylococcus aureus* especially—indicates that the chances are greatly in favor of a bone involvement, the demonstration of organisms of the streptococcus group would speak in favor of a joint involvement. The differentiation carries with it a possible therapeutic indication. Other things being equal, the demonstration of organisms of the staphylococcus group with its consequent interpretation of a bone lesion would ordinarily favor exploration of the bone in cases of doubt, while the demonstration of organisms of the streptococcus group would carry with it a more conservative attitude at least as far as exploration of the bone were concerned.

In cases of acute osteomyelitis the relative magnitude of the bacteriæmia

or general blood infection is capable of yielding information valuable for a correct gauging of the prognosis. This information can be classified as follows:

A In cases of acute osteomyelitis blood cultures showing one or two colonies of organisms to the cubic centimetre of blood are usually but not always of a mild nature, frequently show little or no evidence of their existence, are associated with symptom complexes which do not differ materially from similar cases of acute osteomyelitis in which the blood cultivations are sterile, and frequently disappear spontaneously or following operation. Good prognoses are the rule in these minor bacteriæmias.

B On the other hand blood cultures can be obtained in which the numbers of colonies are extremely large—100 or more colonies to the cubic centimetre of blood. Always this indicates a severe infection and an extremely grave prognosis. The clinical picture commonly shows an equal evidence of the severity of the infection. The interpretation of such blood cultures has been referred to already in considering the fulminant cases of acute osteomyelitis. There will be many cases in this group in which one will have no doubt as to the need for operation upon the local focus of osteomyelitis and one will proceed confidently on these. There will be many other cases in this group in which one will be somewhat in doubt as to the correct interpretation of the relationship of the clinical picture to the bacteriæmia or general blood infection, especially in those cases bordering upon the fulminant cases referred to previously. Under such circumstances one must operate upon the local demonstrable focus of osteomyelitis and remove it radically.

C In between these two extremes are large numbers of cases in which the blood cultivations show an intermediate number of colonies of bacteria. When a given blood culture is compared with subsequent ones taken on the same patient the lessening of the number of colonies, or their disappearance, undoubtedly bespeak an improvement when other conditions are equal, an increase in the number of colonies should always be cause for alarm and for a prompt reconsideration of the available clinical picture and revision of all of the demonstrable foci of infection, whether they be in the bone or in other tissues and organs. Comparisons made along these lines are of extreme usefulness and importance in bedside and operating room work. In any event it will usually, but not always, be found that the bacteriological data correspond quite closely with the variations in the demonstrable subjective and objective clinical picture.

D In the presence of a positive blood culture a prognosis of the ultimate outcome in cases of acute osteomyelitis cannot always be made on the basis of the blood culture findings alone and should not be attempted, except after consideration of all of the available clinical facts. While a positive blood culture is always a serious thing, especially from the point of view of the possibilities which may occur, it is usually found that the seriousness of the latter is paralleled by the characteristics of the clinical picture. The prognosis

should always be guarded. Much depends upon the availableness of the local focus of osteomyelitis for thorough surgical removal and upon the performance of the latter procedure before other complicating foci have appeared.

E Negative (sterile) blood cultures obtained either primarily or secondarily in cases of acute osteomyelitis should not always be associated in one's mind with the milder type of case or with improvement. Quite the contrary can be the case and negative blood cultures can be obtained in the presence of the most severe infections. The available clinical data indicate that the demonstration of a sterile blood culture may be an accident and be associated with the intervals between temporary states of bacteriæmia, the occurrence of complicating and secondary foci, other than the bone focus and subsequently to it, in the presence of negative blood cultures is the most powerful proof of these temporary bacteriæmias.

In the presence of positive and negative blood cultures a progressive impoverishment of the general condition of the patient is frequently due to the magnitude and number of the various fixation points that have occurred or to their location in important viscera or localities of the body rather than to the presence of the blood infection. Positive blood cultures are sometimes only obtainable at a late stage of the illness. Death results either from a general progression of the entire infection or from the results of any one particular manifestation as, for instance, from the results of a localization in the lungs and pleura.

In any given case the presence of a bacteriæmia may be referable (1) to the original primary lesion, (2) to its secondary focus in the bone, (3) to the presence of a focus subsidiary to the secondary focus (to one or other) which by itself is capable of creating a bacteriæmia, (4) to the presence of a valvular lesion arising in some way from the presence of a bacteriæmia, and (5) to the presence of some other complication capable itself of giving rise to a bacteriæmia or general blood infection.

Except in cases of acute osteomyelitis which follow specific infections as typhoid fever, pneumococcus pneumonia, etc., and in which the bone foci make their appearances during the course of the primary illness, the primary lesion to which the focus of osteomyelitis is secondary is not recognizable or demonstrable by the ordinary clinical or laboratory means. In the average case seen the question of the primary lesion does not enter.

In practice one should assume that the bacteriæmia is most likely derived from one or other of the demonstrable bone foci.

Under these circumstances the treatment of the bacteriæmia or general blood infection must be the surgical removal of the focus containing the thrombo-arteritis or thrombo-phlebitis from which the bacteriæmia or general blood infection is derived.

The bacteriæmia should be considered as an indication for immediate operation and its presence and magnitude as a measure of the urgency with which surgical intervention is called for.

THE TREATMENT OF THE LOCAL LESION

The treatment of the local lesion of acute osteomyelitis should be based (1) upon a consideration of the mechanism by which the foci are produced, (2) upon the character of the lesion which is produced, as determined by the available knowledge and by roentgenographic evidence, and (3) in accordance with the magnitude of the infection in association with the absence or presence of bacteraemia. Multiple foci of osteomyelitis should be treated individually along similar lines and in accordance with the viewpoints expressed.

A Other things being equal, the absence of a demonstrable bacteraemia or general blood infection indicates that a conservative attitude can be assumed in deciding the correct method of surgical treatment of the local focus of osteomyelitis.

Under these circumstances the immediate indication to be met is the introduction of adequate drainage, thereafter one should await the full demarcation of the lesion by the natural sequestration which will occur as indicated in the previous part of this and in other communications. The immediate importance of this conservative attitude comprises (1) a much less severe—frequently, indeed, a minor—primary operation, (2) the much less chance of spreading the thrombo-phlebitic or thrombo-arteritic process with all the consequences hereinbefore outlined, (3) the frequent conservation of important bone tissue, (4) the frequent avoidance of unnecessary complications, (5) the ease with which the sequestrotomy can be subsequently performed without undue mutilation of the bone, (6) the lesser chance of secondary and operatively produced spreading of the lesion, (7) the lesser degree of deformity which results, and (8) the greater usefulness of the limb because of less interference with the normal range of motion.

The actual method of introducing drainage into a focus of osteomyelitis depends upon general surgical principles. These comprise (1) the simple opening of subperiosteal abscesses in appropriate cases, and (2) the various forms of osteotomy in which openings are established into the medulla of the bone. In any case free drainage should be provided.

In performing the secondary sequestrotomy only as much healthy bone or involucrum should be removed as to enable one adequately to remove the sequestrum. The main care is not to cause undue mutilation and to prevent the spread of the thrombo-phlebitis inasmuch as this is the chief cause for the subsequent exacerbations or recrudescences in the same focus or in the production of other foci. The resulting wounds should not be sutured and should be allowed to heal from the bottom, either with or without the aid of sterilization by the Carrel-Dakin method.

B Other things being equal, the presence of a demonstrable bacteraemia or general blood infection indicates a dangerous and possibly progressive lesion and bespeaks an urgency of effort which seeks to remove the guilty local focus as early and as completely as possible before irreparable damage is done by the spreading of the infection to the endocardium or other impor-

tant organ or locality. All of the information classified in the previous part of this and in other papers as regards the clinical and the therapeutic significance of a bacteriemia or general blood infection accompanying an acute osteomyelitis come into play at this time and judgments should be based and indications met accordingly.

The important indication is to remove the local focus of osteomyelitis as completely as possible. Conservatism should be replaced by the radical removal of bone tissue frequently into healthy areas. The difficulty at these early stages is the impossibility of being able to recognize the limits of the lesion and much wider excisions of bone tissue must therefore necessarily be done than would otherwise be called for. There are times and localities in which radical removal of the thrombo-phlebitic focus in the bone is not technically feasible, under these circumstances as much as possible should be done in this direction, ample drainage should be secured as the next best thing, and a good deal must be entrusted to nature's efforts in spontaneously dissipating the bacteriemia.

The clinical possibilities which follow operation and the therapeutic indications which are available are the following:

a In many of the cases a single focus of osteomyelitis only is demonstrable. In most of the cases in this group, the comparatively small number of bacteria demonstrable in the blood circulation (plate culture method) indicates the probability that the bacteriemia results from the demonstrable local lesion. If following an adequate operation in which the demonstrable focus of osteomyelitis is removed, the blood becomes sterile, the pre-operative assumption that the bacteriemia had resulted from that particular focus of osteomyelitis becomes confirmed. In some of the cases, however, the bacteriemia persists after operation. When the surgeon is certain that the bone lesion has been so thoroughly removed as to be impossible of causing the bacteriemia and when the appearances of the bone wound corroborates this impression, the bacteriemia should be used as an indication that some other focus exists which must be found and removed in order to render the blood sterile. Many times this proves to be the case, but when it does not the original focus of osteomyelitis should be examined again and revised operatively. If the bacteriemia still persists and the number of demonstrable bacteria is still comparatively small, other foci or lesions capable of causing a bacteriemia should be looked for. In the absence of any such demonstrable lesion the explanation of the bacteriemia cannot be decisive, although it must necessarily be assumed under the circumstances that the original focus continues to discharge bacteria into the blood stream and one should constantly be on guard and act accordingly. Undoubtedly in some cases an obscure primary lesion exists which serves to keep up the bacteriemia. In the meanwhile other foci should be looked for especially during the continuation of the bacteriemia. Fortunately in most of the cases the natural forces of the body are ample after a sufficient lapse of time to render the blood sterile.

b When several foci of osteomyelitis coexist in the presence of a bacteriæmia, the explanation of the latter becomes a matter of exclusion. Similar rules to those outlined in the last paragraph apply.

c In a few of the cases, comparatively speaking, the primary lesion is demonstrable as well as one or more subsidiary bone lesions. In the majority of the cases, the primary bacteriæmia disappears after efficient surgical treatment directed towards all of the demonstrable lesions, primary or other. In a few cases, however, the bacteriæmia persists. Although in some of the latter cases, because of the character of the infecting organism, or because of other reasons, it is possible to say with a fair degree of certainty that the primary lesion is keeping up the bacteriæmia, in all of the others, the proper explanation becomes a matter of exclusion also in accordance with the rules laid down.

d In some of the cases of acute osteomyelitis with bacteriæmia a subsidiary focus has developed in a tissue or organ other than bone, or a complication develops which is unrelated to the osteomyelitis. Except in those cases of complication in which the latter is known from previous experience to cause a bacteriæmia or general blood infection, the proper explanation again becomes a matter of exclusion as previously indicated.

e In any case in which the question of the bacteriæmia cannot be adequately explained, and in which it continues to exist, a bacterial endocarditis should be looked for. The presence of the latter is the most serious complication possible and a very grave prognosis should be made, operation upon any local focus is futile in the presence of a bacterial endocarditis and a fatal outcome should be expected.

Many of the statements made in the last classification are equally applicable before operation. At any time, either before or after operation, patients in the first four groups of this classification may progress into the group of most severe and fulminant cases. They then assume the characteristics of the cases in this group and the clinical manifestations increase in gravity proportionately and absolutely. Similar therapeutic indications exist as were previously pointed out. It is very rare for the opposite course to be followed. This change has intimate relations with a spread of the thrombophlebitis as previously referred to and may occur spontaneously either before or after operation or as a consequence of the latter. The possibility of this change occurring spontaneously before operation in cases of acute osteomyelitis, even when previously a sterile blood culture had been obtained, is the chief reason for considering cases of acute osteomyelitis emergency cases which brook of little or no delay before operation. On the other hand, this can occur subsequently and at comparatively late periods and even be associated with so-called exacerbations or recrudescences in healed foci of osteomyelitis.

The phenomena accompanying the spread of the thrombophlebitis are particularly apt to occur after operation. They characterize a group of cases of osteomyelitis which directly after operation do not exhibit the expected

TREATMENT OF ACUTE OSTEO-MYELITIS

retrogression and disappearance of the local inflammatory effects and a subsequent healing, but which, instead show an increase, large or small, in the local focus. Exhibiting the same characteristics of the early unoperated cases of osteomyelitis the ontogenological evidences of these phenomena are not immediately visible and are recognizable only later when the full effects of the increase in the thrombo-phlebotic process has become sufficiently established. Clinically, these are recognizable by the continuation of the subjective phenomena or by recrudescences or exacerbations of the process. Inasmuch as the essential mechanism of these post-operative phenomena are similar to those which occur spontaneously and before operation, similar results follow. All of the characteristic phenomena which have been described in the previous part of this and in other communications as regards the spreading of the original foci or the formation of additional foci within the confines of the same bone can and do occur post-operatively and are a direct consequence of the operation. In this respect it is to be emphasized that the characteristics of the thrombo-phlebitis are aided and abetted by the operative manipulations and that the latter play a role only in this way. It must be further emphasized that in no other way could the extraordinary and bizarre effects which are clinically seen to interfere with the control of the process and to disturb the smoothness of the healing of the wound be satisfactorily explained.

Other factors enter into the problem when joint complications occur and when epiphyseal lines become part of the focus of infection, especially in younger individuals. Absorption phenomena and disturbances of growth then take place which are important factors in determining the end results of the focus of infection. The discussion of all these problems is reserved for another communication.

The experiences upon which the viewpoints and conclusions of this communication are based are derived from clinical observations upon patients admitted to the service of Dr. A. V. Moschowitz at Mount Sinai Hospital and upon patients in my own private practice. I am indebted to Doctor Moschowitz for permission to make these observations upon the patients admitted to his service.

FAT NECROSIS OF THE BREAST

A STUDY OF TWENTY CASES

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THE recognition of fat necrosis of the breast is important because of its close similarity to carcinoma both clinically and in gross pathological appearance. This subject was first studied comprehensively by Lee and Adair¹ in 1920, under the title "Traumatic Fat Necrosis of the Breast." In 1924, these authors² reviewed the twenty reported cases, and gave a complete description of this condition.

All the cases are said to occur in obese women and usually to follow some direct trauma to the breast. A mass develops within the breast, or in the subcutaneous tissue overlying it. This mass is usually painless. It is at first freely movable, but as the process progresses, fixation of the tumor to the surrounding tissues results. The nipple is seldom retracted, a fact which helps in the differentiation of this condition from malignancy. The axillary and supraclavicular nodes are seldom palpable.

Ewing³ describes the pathological differentiation of this benign lesion from cancer as follows: "In traumatized fat the nodules are irregularly distributed throughout the breast and fade into the surrounding breast tissue, while carcinomatous nodules occur singly and are sharper in outline. The newly formed connective tissue of fat necrosis is red, due to the formation of fine capillaries which are absent in carcinoma. Later, cicatrization obliterates these capillaries and the connective tissue of fat necrosis becomes as dense and opaque as in carcinoma. On section, the fat cells lying in cicatricial connective tissue resemble the small alveoli of carcinoma. The presence, however, of fibroblasts, mingled with lymphocytes, empty fat spaces, phagocytic giant cells and wide areas of proliferating fat cells, helps to differentiate this condition from cancer."

In our series, the most striking and characteristic histological findings were disorganized fat cells, invaded by newly formed connective tissue, with deposits of fatty acid crystals, often taking the typical rosette form. Surrounding the fat crystals were numerous small and large giant cells of the foreign body type. At the periphery of the lesion young proliferating fat cells and cells laden with pigment were often found.

Fair,³ in 1923, was able to reproduce experimentally the characteristic lesion of fat necrosis by pinching the subcutaneous fat of pigs with forceps. Sections made of the injured areas showed the typical histological picture of fat necrosis, and in freshly stained preparations fatty acid crystals were

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readily demonstrated. From his studies he concluded that in an area of traumatized fat, the lipolytic enzyme present in all normal body fat and blood, is liberated, and acts upon the neutral fat in the traumatized area, breaking it down into its component parts, fatty acid and glycerol. These substances form the irritant which give rise to the foreign body reaction, producing the lesion of traumatic fat necrosis.

A case of undoubted fat necrosis recently came to our attention in which trauma could not be considered as the etiological agent (CASE VIII). It occurred to us, after a study of this case, that a critical examination of the cases of fat necrosis on record at the Mt Sinai Hospital and a review of a series of breasts removed for non-malignant conditions might throw further light on the etiology of this condition. Seventy-eight cases in all were studied, and in fourteen of them some stage or degree of fat necrosis was found. A clinical analysis of these cases presented certain interesting facts.

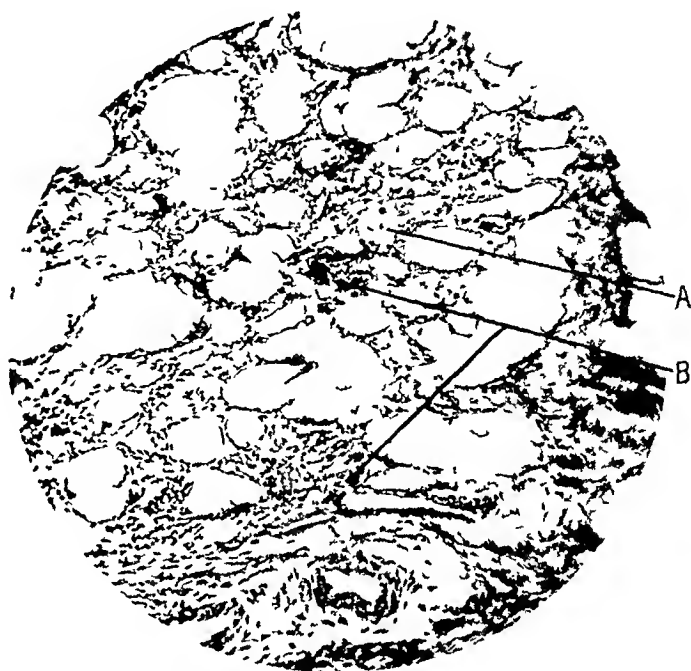


FIG. 1.—From a case in Group 1 showing disorganized fat tissue invaded by connective tissue. A New formed fat cells. B Giant cells.

Age—The age incidence in our series ranged from nineteen to sixty years, but the majority of cases occurred in the fourth and fifth decades of life, falling within the so-called cancer age.

Obesity—Six cases have a definite history of general obesity and unusually fatty breasts. Two cases are definitely recorded as not obese, and in one case the patient was emaciated.

Pain—The breast was the seat of pain in six cases, in four of which the breast tissue showed some other concurrent pathological condition besides that of fat necrosis.

Consistency of the Tumor—The tumor was of stony hardness in twelve of the cases and in one case it fluctuated.

Fixation to the Skin—Skin fixation was present in five cases, and noted as absent in seven cases.

Nipple Retraction—This phenomenon occurred but once in the series.

Size and Situation of the Mass—The lesion varied in size from 1 mm. to 5 cm. in diameter and was not confined to any particular quadrant of the breast.

Trauma—A positive history of trauma to the breast preceding the formation of the lesion was obtained in only one out of our series of fourteen cases. In two others the lesion followed a surgical procedure. Of these, one case occurred soon after a radical mastectomy and simulated recurrent carcinoma in the operative scar. The other case developed in the scar of a previous incision for a breast abscess. In three of the cases there is only questionable evidence of trauma to the breast, such as application of a hot compress for a short while, a fall five months before the development of the

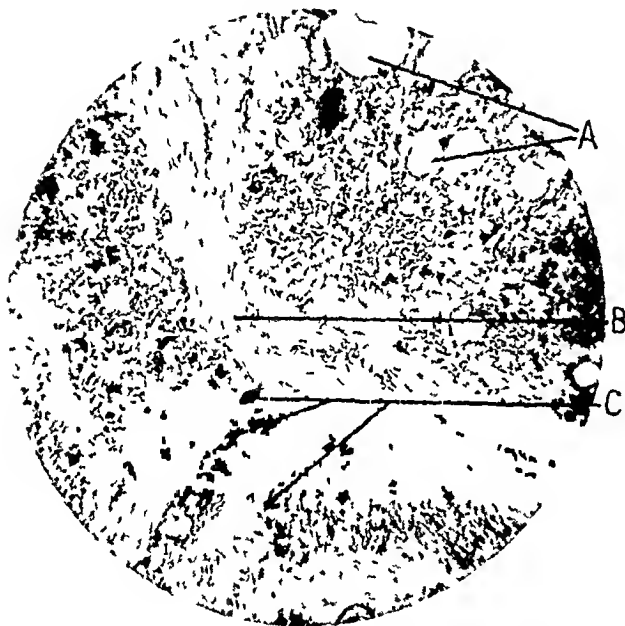


FIG. 2—From 1 case in Group 2. Showing A, empty fat spaces and B, dense connective tissue. C, Giant cells.

Group 2—Fat necrosis occurring as a single tumor mass in an otherwise normal breast (Figs. 2 and 3).

Group 3—Fat necrosis occurring as multiple punctate areas in a breast the seat of some other pathological process (Figs. 4, 5, 6).

Group 4—Fat necrosis occurring in a lipoma of the breast (Fig. 7).

REPORT OF CASES

Group 1—Fat necrosis occurring in the subcutaneous tissue overlying the breast. Three cases.

CASE I—A G., aged fifty-two, admitted to the Mt. Sinai Hospital, March 4, 1925, complaining of lumps in the right breast and right inguinal region. Patient is married and has five children. Two weeks before admission, patient fell and sustained a contusion of the right hip. A week later she noticed enlarged inguinal glands on the right side. Five days before admission she noticed a mass in the right breast which was painless.

The general physical examination was negative. In the right breast, 4 cm. above the nipple, there was a small firm nodule apparently attached to the deeper tissues. The overlying skin was freely movable. The nipple was not retracted, axillary nodes were not palpable. In the right inguinal region, a few hard lymph-nodes were palpated.

Operation—Under gas and ether, a hard nodule, 2 cm. in diameter, embedded in fat

lesion or an accident during which a contusion of the hip was sustained. In seven cases the histories definitely state that there was no trauma preceding the development of the lesion in the breast. In one case, the history contains no reference to the question of trauma.

A careful study of our cases show they can be divided into four groups, depending upon pathological picture presented.

Group 1—Fat necrosis occurring in subcutaneous tissue overlying but not involving breast (Fig. 1).

FAT NECROSIS OF THE BREAST

was removed from the breast. At the same time, a mass about 5 cm in diameter, was excised on the right side above Poupart's ligament.

Gross Description—The mass removed from the breast consisted of fat showing scattered areas of firmer consistency arranged in a radial manner, and on section presented a dull grayish-white color, with small cystic and hemorrhagic areas.

Microscopic Report—Fat tissue showing fat necrosis. It is interesting to note that the mass in the inguinal region was also fat necrosis.

CASE II—E S, aged forty-two, admitted to the Mt Sinai Hospital, January 3, 1921, complaining of a lump in the scar of a previous operation. Seven weeks before admission, patient had a radical mastectomy for a tumor of the right breast, which was reported inflamed and degenerated medullary carcinoma. For the past two weeks patient had noticed pain in the axillary portion of the scar on moving the arm, and noticed the appearance of a slowly growing lump.

The general physical examination was negative except for marked obesity. The upper axillary portion of the scar was nodular infiltrated and appeared to be attached to the chest wall. This area was neither red nor tender. No enlarged lymph-nodes were to be felt and there were no nodules in the surrounding skin.

Operation—Under the diagnosis of recurrent carcinoma, excision of the nodule with the surrounding skin was carried out. The mass was adherent to the chest wall and the axillary vein. A small amount of pus escaped during the dissection, the exact source not being determined.

Gross Examination—Specimen consisted of resected portion of tissue measuring about 15 cm in diameter, including old scar from previous operation. There was marked infiltration of the subcutaneous tissue in the region of the scar, which on section appeared cellular and fibrous, suggesting recurrent carcinoma.

Microscopic Report—Section contained skin, sebaceous glands, hair follicles and surrounding fat. The skin was negative. Fat tissue showed typical fat necrosis.

CASE III—D F, aged thirty-five, applied to her local physician, complaining of a lump in the breast. A year and a half ago, patient noticed a small lump in the right breast. She was attended by a local physician, who incised what appeared to be an abscess and packed the wound. The wound healed slowly, requiring several months for complete closure. After healing, a small nodule was left, which persisted up to the present illness. Since the previous operation, a small superficial lump remained in the skin over the breast, not tender, not increasing in size.

The general physical examination was negative. In the skin of the right breast, there was a small nodule, 1 cm in diameter, hard but not tender, freely movable on the underlying structures.

Operation—Under local anæsthesia, the nodule with the surrounding tissue was excised. At operation, the lesion appeared cystic.



FIG 3—From a case in Group 2 showing A fat crystal deposit B pigment containing cells on periphery and C, giant cells

Microscopic Report—Section consists of skin and subcutaneous fatty tissue. Directly beneath the skin, there was a circumscribed area of typical fat necrosis, about 5 mm in diameter, with some atypical proliferation of surface epithelium into it.

Group 2—Fat necrosis occurring as a single tumor mass in an otherwise normal breast Five cases

CASE IV—E. N., aged fifty-four, was admitted to the Mt. Sinai Hospital, June 6, 1923, complaining of a lump in the right breast. Six months ago, a tumor of the left breast, which occurred after a trauma, was removed. This was reported typical fat necrosis and

was included in the series reported by Lee and Adair. For the past four weeks, patient noticed a lump in the right breast, which was neither painful nor increasing in size. There was transient redness of the skin over the area. Patient had no fever or chills, and remembers no distinct trauma to the breast.

The general examination was negative. In the upper and outer quadrant of the right breast, there was a small nodule about the size of a pea. The nodule was tender with an area of softening about it.

Operation—Under local anesthesia, two small nodules each the size of a pea, were shelled out. They were firm, yellowish in color, and on section

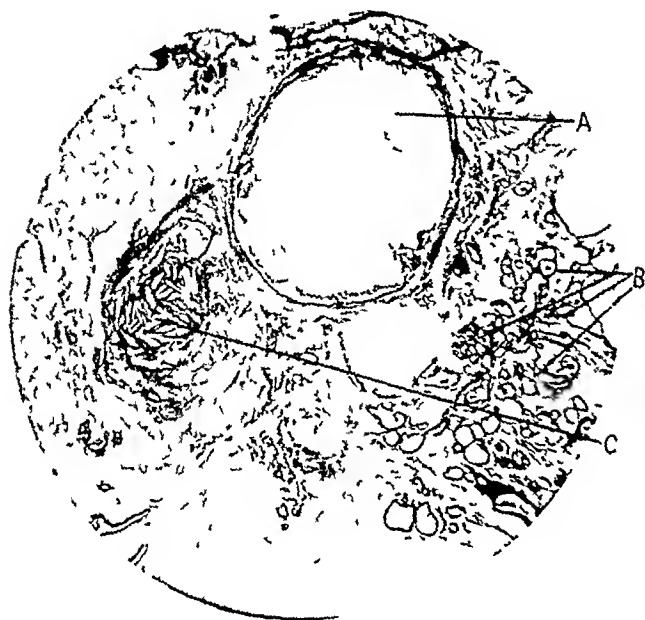


FIG. 4.—From a case in Group 3 showing A, dilated duct; B, disorganized breast acini; C, area of fat crystal deposit.

tion showed small whitish areas. *Microscopic Report*—Section contained small fragments of breast tissue and surrounding fat. Breast tissue showed no lesion. Fat tissue showed typical fat necrosis.

CASE V—R. K., aged sixty, was admitted to the Mt. Sinai Hospital, October 26, 1925, complaining of a lump in the left breast. Patient is married, and has had several pregnancies. Artificial menopause fifteen years ago following hysterectomy. Three weeks ago patient noticed redness of the left breast, about 3 cm above the nipple. This directed her attention to a lump in this situation which was not painful. Patient attributed the presence of this lump to a fall sustained five months previously.

The physical examination was negative. In the left breast, in the mid-clavicular line above the nipple, there was a flattened, hard, non-tender mass, about 2 cm in diameter. The mass moved with the skin, and seemed to be attached to it. It was not, however, attached to the deeper structures. There was one small hard lymph-node in the left axilla.

Operation—Under local anesthesia, the mass above described was excised, appearing grossly like altered fat.

Microscopic Report—Section consists for the most part of breast tissue, showing changes coincident with involution. Surrounding fat shows the typical picture of fat necrosis.

CASE VI—R. F., aged sixty, was admitted to the Mt. Sinai Hospital, April 9, 1926, complaining of swelling and tenderness in both submamillary regions. Patient is married and has several children. For the past few weeks, patient had noticed swelling and

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tenderness of the submaxillary glands without fever or constitutional symptoms. She did not complain of any symptoms associated with her breasts.

The general physical examination was negative. Both submaxillary glands were swollen, painful and tender. During the examination, a lump about 1 cm in diameter, was discovered in the left breast. There was no history of trauma to the breast.

Operation—Both submaxillary glands were excised and reported chronic inflammation. A week later, a local excision of the breast tumor with surrounding breast tissue was carried out.

Gross Description—Specimen consisted of breast tissue, measuring 7 x 7 x 3 cm in



FIG. 5—From a case in Group 3 showing A, dilated duct with defective wall. B, adjacent area of fat necrosis containing rosette of fat crystals.

diameter, of brownish color, which on section cut with a grating sound and glistened as from a surface of myriads of tiny lenses.

Microscopic Report—Sharply demarcated from surrounding breast and fatty tissue was an area of fatty acid crystals, each clump of crystals being surrounded by inflammatory reaction typical of fat necrosis. Surrounding this area, there were large numbers of cells laden with pigment.

CASE VII—D. L. B., aged fifty-six, was admitted to the Montefiore Hospital on April 6, 1926, complaining of a lump in the right breast. Patient is married, and has four children, living and well. Six months before admission, patient fell down a flight of stairs, striking the right breast. The right breast immediately became swollen and discolored. Several days later, the patient noticed a hard mass in the upper and inner quadrant of the right breast, which grew rapidly to the size of a hen's egg and then diminished somewhat in size. The mass was not painful.

The general physical examination was negative except for marked obesity. In the upper and inner quadrant of the right breast, there was a hard, plum-sized mass which

was freely movable on the skin and deeper tissues. There was no discoloration of the skin, retraction of the nipple or palpable axillary lymph-nodes.

Operation—Under local anæsthesia, enucleation of the tumor mass from the surrounding breast tissue was performed.

Gross Description—Specimen consists of fatty tissue containing scattered islands of soft, yellow material, studded with minute foci of yellowish necrosis.

Microscopic Report—Fatty tissue showing typical fat necrosis.

CASE VIII—X Y, aged forty-six, admitted to Flower Hospital, April 22 1926, complaining of a lump in the left breast. The patient is married, with several children.



FIG. 6.—From a case in Group 3 showing A dilated duct with defective wall B periductal inflammatory changes C, areas of necrosis

living and well. Two weeks before admission patient noticed pain in the left breast. She applied hot compresses to it, with relief of pain. Shortly thereafter, patient discovered a lump at the site of application of the hot compresses. There was no history of mechanical trauma.

The general physical examination was negative except for marked obesity. In the upper and inner quadrant of the left breast, there was a hard mass the size of a hen's egg, not adherent to the skin or to the deeper structures. There was no retraction of the nipple, ecchymosis or palpable lymph-nodes.

Operation—Under general anæsthesia, a simple mastectomy was carried out, removing skin and nipple with breast tissue in one piece.

Gross Description—Specimen consisted of two pieces of tissue made up of interlacing fibrous septa enclosing irregular small foci of translucent, yellowish tissue, containing central areas of opaque yellowish-white necrosis. The translucent yellowish areas suggested the lobulation of a duct or gland structure, the central areas of which were necrotic.

Microscopic Report—Fat necrosis.

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Group 3—Fat necrosis occurring as multiple punctate areas in a breast the seat of some other pathological process Five cases

CASE IX—H A, aged thirty-seven, admitted to the Mt Sinai Hospital, August 14, 1923, complaining of a lump in the left breast. Patient is single and has never lactated. Two months ago, patient accidentally discovered a lump in the left breast. Lump varied in size at the menstrual periods. The lump never caused pain, but there was vague discomfort in the left axilla, shoulder and back. There was no bleeding or discharge from the nipple, no history of trauma, fever or chills.

The general physical examination was negative. In the middle and upper quadrant of the left breast, there was a hard mass, irregular in outline, the size of a small egg. It was freely movable under the skin and slightly tender to palpation. There was no nipple retraction or dimpling phenomenon. A few small glands were felt in the left axilla.

Operation—Under gas and ether anaesthesia several cysts of the breast, some of a bluish color, were shelled out by blunt dissection.

Gross Description—Specimen consisted of a mass of tissue, measuring 5 x 10 cm. This tissue was made up of many cysts which contained clear fluid. The cysts did not communicate with each other.

There was also a denser portion, which on section had the

gross appearance of normal breast tissue. *Microscopic Report*—Sections consisted of breast tissue, the seat of marked cystic and inflammatory changes coming under the head of chronic cystic mastitis. Alongside of a widely dilated duct, the wall of which was defective in one area, there was a focus of typical fat necrosis about 3 mm in diameter.

CASE X—R C, aged nineteen, admitted to the Mt Sinai Hospital, complaining of a lump in the left breast. Patient is single and has never lactated. For the past three months, patient noticed a lump in the left breast which was somewhat painful and seemed to vary in size. There was no history of trauma.

The general physical examination was negative. There was a localized tumor, about 2½ x 3 cm in diameter in the lower medial quadrant of the left breast. This mass was of dense consistency. There was no discoloration of the skin, retraction of the nipple or fixation to the skin or deeper tissues. There were no palpable axillary lymph-nodes.

Operation—Under local anaesthesia, a mass the size of a walnut, which appeared cystic, was shelled out from the breast substance.

Gross Description—Specimen consisted of breast tissue and fat about 3 cm in diameter, showing a few cavities and yellowish-white areas in the fat.

Microscopic Report—Sections show breast tissue, the seat of marked cystic disease. In close relationship with cystic spaces and dilated ducts were several areas of typical fat necrosis, each about 2 or 3 mm in diameter.



FIG. 7.—From a case in Group 4 showing A broken down fat B Giant cells

CASE XI—G C, aged thirty-six, admitted to Mt Sinai Hospital, April 10, 1926, complaining of a lump in the left breast. Patient is married and has two children living and well. She was in Mt Sinai Hospital five years ago for diabetes of a severe grade. Her diabetes is now under control. Three weeks ago, patient noticed a mass in the left breast. Since noticing the mass, patient felt weak and had a painful sticking sensation in the breast.

The general physical examination was negative except for poor nutrition. In the left breast, which was small and atrophic, there was a firm, irregular, bilobed mass, freely movable on the skin and deeper tissues. There was a smaller lobe just beneath a lactiferous duct and firmly attached to it. The mass was not tender. There was one small hard lymph-node in the left axilla.

Operation—Under local anæsthesia, the tumor in the breast was excised.

Gross Description—Specimen consisted of a mass of breast tissue showing numerous small cysts, the contents of which were a yellowish semi-solid substance.

Microscopic Report—Sections showed breast tissue the seat of a marked inflammatory and cystic disease. There were two areas, each about 2 mm in diameter, of typical fat necrosis, one of which contained a fresh fatty acid crystal deposit. The other area was situated alongside of a dilated duct with defective walls.

CASE XII—B A, aged forty-eight, admitted to Mt Sinai Hospital, October 31, 1923, complaining of a lump in the right breast. Patient had not lactated for seventeen years. She has had diabetes for two years. Five days ago, patient suddenly experienced pain in the right breast, and on manipulation discovered a lump there. There was no history of trauma, infection or discharge from the nipple.

The general physical examination was negative. The nipple of the right breast was retracted, and to the inner side of it there was a lump the size of a lemon. This mass was hard, attached to the skin but not to the underlying tissues. It was slightly tender, but neither red nor hot. There were no axillary nodes to be felt, but there was some induration in the right axilla.

Operation—Under gas and ether, a local excision of that portion of the breast apparently affected was carried out. As the mass was excised, inspissated material was expressed from the dilated ducts.

Gross Description—Specimen consisted of several masses of breast tissue which felt hard, and on section showed dilated ducts. The tissue had the appearance of mastitis without any evidence of malignancy.

Microscopic Report—Sections showed breast and fatty tissue the seat of marked chronic purulent processes. There were dilated ducts with defective walls surrounded by hyaline connective tissue and phagocytic cells filled with fat. One area about 5 mm in diameter showed typical fat necrosis.

CASE XIII—S B, aged forty-five, was admitted to Mt Sinai Hospital in 1913 complaining of a red, swollen and hot right breast. Patient was married and had eleven children. For the past two months the right breast had been swollen, red and hot, and was constantly painful. Three weeks ago the process ruptured spontaneously, and discharged in three places. There was no history of trauma.

The general physical examination was negative. The right breast was reddened, swollen and tender. The induration extended 4 cm to either side of the nipple and deep into the breast tissue. The entire breast was tender. There were three sinuses discharging pus.

Operation—Under ether anæsthesia the sinuses were incised and several abscesses opened into and drained. A hard mass was found in the centre of the breast, which simulated a neoplasm. A portion of this was removed.

Microscopic Report—Sections showed fat and fibrous tissue, no breast elements being identified. The tissue was the seat of a marked infiltration with round cells and polymorphonuclear leucocytes and large numbers of phagocytes filled with fat. There were several areas of typical fat necrosis, with giant cells and newly formed fat cells.

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TABLE I

Group IV	Group III	Group II	Group I	Case	Age	Duration	Trauma	Pain	Obesity	Skin discoloration	Tumor hardness	Nipple retraction	Skin fixation	Deep attachment	Axillary nodes	Pathological description
				1 A G	52	1 wk	?	0		0	+	0	0	+	0	Gross Mass of fat with dull grayish-white areas and cystic spaces <i>Micro</i> Fat necrosis
				2 E S	42	3 wks	Surgical +	+	+	0	+		+	+	0	Gross Mass of skin and indurated fat <i>Micro</i> Skin neg Fat shows fat necrosis
				3 D F		1 yr	Surgical +				+	0	+	0		<i>Micro</i> Area of fat necrosis directly beneath skin with atypical epithelial proliferations into it
				4 E N	54	1 mo	0	0	+	Transient	+	0				Gross Fragments of breasts and fat <i>Micro</i> Breasts—neg Fat—fat necrosis
				5 R K	60	3 wks	?	0		+	+		+	0	+	Gross Fragments of breast and fat <i>Micro</i> Breast—neg Fat—fat necrosis
				6 R F	60	?	0	0	0	0	+	0	0	+	0	Gross Breast tissue containing small brownish nodule <i>Micro</i> Fat necrosis surrounded by pigment cells
				7 D B	56	6 mos	+	0	+	0	+	0	0	0	0	Gross Fat tissue with yellowish areas <i>Micro</i> Fat necrosis
				8 X Y	46	2 wks	?	0	+	0	+	0	0	0	0	Gross Fat and breast tissue with yellowish areas in it <i>Micro</i> Breast—neg Fat—fat necrosis
				9 H A	37	2 mos	0	0			+	0	0		+	Gross Breast tissue with clear fluid cysts <i>Micro</i> Fat necrosis near dilated duct
				10 R C	19	3 mos	0	+	0	0	+	0	0	0	0	Gross Breast and fat tissue <i>Micro</i> Cystic disease of breast Areas of fat necrosis, some near cystic spaces
				11 G C	36	3 wks		+	0		+	0	0	0	+	Gross Cysts in breast containing semisolid material Cystic and inflammatory disease of breast <i>Micro</i> Small areas of fat necrosis near cystic space
				12 B A	48	5 days	0	+		0	+	+	+	0	0	Gross Breast tissue with dilated ducts <i>Micro</i> Purulent inflammation One area of fat necrosis
				13 S B	45	2 mos	0	+	+	+	+		+	+		Gross Fragments of breast tissue <i>Micro</i> Infiltrated breast with areas of fat necrosis
				14 H L	39	2 mos	0	+	+	0	0	0	+	+	0	Gross Encapsulated mass of fat with small necrotic focus in it <i>Micro</i> Normal fat with one area of fat necrosis

Group 4—Fat necrosis occurring in a lipoma of the breast

CASE XIV—H L, aged thirty-nine, admitted to Mt Sinai Hospital, April 3, 1923, complaining of a lump in the right breast. Patient has been married nineteen years, and has had three children. Fourteen months ago patient experienced a sticking pain in the right breast which grew progressively worse until it involved both breasts. Two months ago patient noticed a small tender lump in the outer part of the right breast. This mass has not increased in size. The skin over it was not ulcerated or reddened.

The general physical examination was negative except for marked obesity. At the junction of the upper and lower right quadrants of the right breast was a lump the size of an egg. It was deeply situated in the breast and fluctuated. There were no axillary nodes palpable. There was no discoloration of the skin or retraction of the nipple. The left breast was swollen, but showed no localized masses.

Operation—Through a Warren incision, a fatty tumor the size of a hen's egg was shelled out from the breast tissue.

Gross Description—Specimen consisted of a tumor mass measuring 7 x 4 cm, which on section was a typical lipoma covered by a very thin fibrous capsule. This mass contained one small necrotic focus about 1 cm in diameter.

Microscopic Report—Section consisted for the most part of normal fat tissue. The necrotic areas showed typical fat necrosis.

In examining the private records of the late Dr. F. S. Mandlebaum, six cases reported as fat necrosis were found. The clinical histories of these cases were not available. Examination of the slides showed that they could be classified according to our grouping.

GROUP 1

CASE XV—M. Sections contain skin, subcutaneous fibrous and fatty tissue, with nerve fibres and sweat glands. Fat and fibrous tissue is densely infiltrated with lymphocytes and phagocytic cells filled with fat. Several punctate areas of fat necrosis were present with marked fibrous invasion of the fat.

CASE XVI—D. Sections consist of fat tissue showing fat necrosis in an early stage, and without any breast elements.

CASE XVII—B. Sections consist of fat tissue, without breast elements, the seat of typical fat necrosis in an advanced stage with marked fibrosis and phagocytosis of fat droplets within giant cells.

GROUP 2

CASE XVIII—E. Sections include pieces of breast tissue showing pericanalicular fibro-adenoma and three pieces of fat showing a late stage of fat necrosis, one piece having a small shred of breast tissue at its margin, somewhat fibrotic and infiltrated with lymphocytes.

GROUP 3

CASE XIX—Sections consist of breast tissue, the seat of marked cystic disease and diffuse purulent inflammation. Many areas of fat crystal deposit are present, surrounded by giant cells, several of these areas are in close relation to dilated ducts.

CASE XX—K. Sections consist of breast tissue, the seat of a chronic inflammatory process with dilated ducts. There are two nodules, each about 5 mm in diameter, of fatty tissue, containing polymorphonuclear cells, giant cells, phagocytic cells filled with fat and newly formed fat cells.

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In correlating the pathological with the clinical picture in these cases, it is interesting to note, that the only case with a positive history of trauma and the three cases in which trauma was a questionable factor occurred in Groups 1 and 2. In the cases of these groups, fat necrosis was the sole pathological lesion, either overlying or within an otherwise normal breast. It is probable that the study of cases of this type by previous observers, led them to call this lesion "traumatic" fat necrosis, since there was no other available explanation for its presence.

It was a study of the cases of Group 3 which suggested to us the possibility of other etiological agents. In this group the fat necrosis occurred as minute foci in breasts the seat of some other pathological change, either inflammatory or cystic. In none of these cases can trauma be seriously considered as a causative factor, since in none of them could any history of injury to that breast be obtained. The most constant pathological finding was the intimate relationship of minute areas of fat necrosis, 2 to 5 mm in diameter, and dilated ducts or cystic spaces filled with fatty debris. This occurred in six out of the seven cases of this group and was accompanied by desquamation of the epithelium of that duct, loss of continuity of its wall, and periductal inflammatory changes shading off into the fat necrosis close by. It is probable that the escape of fatty material from one of these ducts or cystic spaces and its subsequent decomposition may form the irritant which causes the necrosis of the adjacent fat.

We feel, therefore, that the term traumatic fat necrosis is inadequate to explain all the manifestations of this process.

CONCLUSIONS

1. Fat necrosis of the breast is evidence of the response of fatty tissue to an irritant.
2. Factors other than trauma may explain this phenomenon.
3. In our series, trauma as the etiological agent was an infrequent and often questionable factor in the production of this lesion.
4. Fat necrosis frequently occurs in association with diffuse inflammatory or cystic disease of the breast.
5. It is highly suggestive that the escape of fatty material from a dilated duct and its subsequent decomposition plays a rôle in the causation of this process.

We wish to thank Drs. A. A. Berg, E. Beer, C. A. Elsberg, A. V. Moschcowitz and H. Neuhof, on whose services these cases occurred, for allowing us to publish them, and Drs. P. W. Aschner, S. H. Geist, L. Cross, and P. Klemperei for kindly reviewing the microscopic slides.

BIBLIOGRAPHY

- ¹ Lee, B. J., and Adair, F. *ANNALS OF SURGERY*, 1920, vol. lxxii, No. 2, p. 189.
- ² Lee, B. J., and Adair, F. *ANNALS OF SURGERY*, November, 1924, vol. lxxv, No. 5, p. 670.
- ³ Farr, C. E. *ANNALS OF SURGERY*, 1923, vol. lxxvii, No. 5, p. 513.

VALUE OF X-RAY IN DIAGNOSIS OF PERFORATED DUODENAL ULCER

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THE United States Fleet consists of ships afloat on the high seas. Essentially a mobile organization it cruises each year long distances and for weeks at a time far from shore bases and many days sea travel from ports where hospitals are to be found. To meet the peace time medical and surgical needs of the personnel of these ships, well equipped sick bays manned by Naval Surgeons and their assistants exist on each of the larger ships. The Naval Surgeons attached to these ships know that they must keep themselves prepared to meet medical and surgical emergencies and not infrequently that they must meet them alone. They cannot always send their hospital cases to a hospital. The Navy Department however recognizes the need for group medical practice in the Fleet and for the equipment that can only be supplied by a hospital and so, attached to each major geographical division of the Fleet is a hospital ship, the *Relief* for the west coast group and the *Mercy* for the east coast group. Each of these ships carries a well balanced group of doctors organized for group medical and surgical practice and each has a medical equipment and personnel recognized by the American College of Surgeons as being up to its standard requirements for Class A hospitals. Whenever possible, patients in need of hospital care are transferred for treatment to these hospital ships.

Among the surgical emergencies normally considered in need of hospital care, one which strikes with almost lightning speed requiring early diagnosis and prompt surgical relief is the perforated ulcer of stomach or duodenum. During the twelve-month period ending October 31, 1926, it so happened that there occurred among the personnel of the battleship divisions of the Pacific Fleet eight cases of ruptured ulcer of the duodenum. One of these developed on a ship at the time distant from the hospital ship and was operated upon by the ship's medical officer and the other seven cases were received aboard the hospital ship *Relief* and operated upon by the surgical staff of that vessel. Some of these came while the vessels of the Fleet were at anchor in port, others while the vessels were at sea. In two cases it was necessary for the ships to drop out of line during manœuvres to transfer these acutely ill persons from a ship busy at target practice to the more quiet environment of the hospital ship. That all eight of these cases were recognized on ships at sea and prepared for operation within ten hours of onset of symptoms is an index of the alert attitude of the Naval Surgeon

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toward surgical emergencies and demonstrates that early diagnosis, rapid transportation for the sick and prompt surgical relief are as much a factor of Navy life today as they are in civilian communities ashore

The total average personnel of the battleship divisions of the Pacific Fleet is approximately 10,000 and it is perhaps a little unusual that eight cases of perforated or ruptured duodenal ulcer should have developed in a twelve-month period in a group of that number. The incidence of this rather rare catastrophe must vary considerably with different surgeons and at different hospitals. The Surgeon General's annual reports for the years 1924 and 1925 show less than eight cases for each of those years among the entire Naval personnel of over 86,000 persons. Moynihan in his abdominal operations—1926 Edition says "At the Leed's Infirmary in the year 1923 there were 56 cases of perforated duodenal ulcer." In contrast to this is the statement of Young of Glasgow quoted from the proceedings of the Mayo Clinic for October 18, 1926 "Hardly a receiving day passes without one or more cases of perforated duodenal ulcer coming into my wards. On occasion I have received as many as half a dozen in one day." The surgical service of the *Relief* realizes that in reporting this small series of cases it can only repeat some of the well known facts about this usually rather clear cut clinical entity. The report is written to emphasize the use of a diagnostic sign obtained by X-ray which has not been heretofore frequently reported in articles dealing with this subject.

The diagnosis of a typical case, stricken suddenly by what obviously is an abdominal catastrophe is not difficult. The rigid abdomen, acute pain, tender upper right abdomen, the facies of shock, the vomiting, the rising pulse, high white count and high polymorphonuclears make a picture for the alert diagnostician familiar with this emergency which necessitates but one decision, immediate operation. Every case however is not so typical. Moynihan states "The clinical picture of appendicitis is copied with such accuracy that out of 49 recorded cases tabulated by me in the *Lancet*, in 18 the first incision was made over the appendix after a diagnosis of acute appendicitis had been made." The symptoms vary with the time after onset. The shock is not always seen, it often is transitory or slight in degree, a brief period of partial remission of the symptoms not infrequently will occur. Three definite stages which merge rather rapidly one into the other are always present and the symptoms change as the underlying pathology changes. Thompson in *Surgery, Gynecology and Obstetrics* of March, 1926, designates these "(1) The stage of contamination, (2) reaction, (3) stage of peritonitis. In the first stage shock may be the overshadowing clinical entity. A history of antecedent chronic pathology may be at that time difficult to obtain. The patient can think only of his extreme pain, and his mind and nervous system are entirely occupied with the effort required to keep his abdomen hard, his knees drawn up and his respiratory rate restricted to lessen the agony into which the sudden contamination of his peritoneum with

acid gastric juices has precipitated him. In this stage and even in the late stages, other conditions as possibilities enter the mind of the observer, diaphragmatic pleuro-pneumonia, gall-stone colic, acute obstructive cholecystitis, acute pancreatitis, perforated appendix, ectopic pregnancy and incarcerated hernia. In the second stage the gradually subsiding pulse, the softening abdomen, the disappearance of shock and the patient's sense of slight improvement may tend to stay the action of the clinician and lead him to believe the storm is passing and that after all he is to have time for a



FIG. 1.—Skilograph showing presence of gas between the diaphragm and the liver

carefully considered diagnosis. In this stage of reaction we have the acid gastric juice becoming diluted by the peritoneal exudates and the flowing of this material over the hepatic flexure of the colon into the right gutter so that symptoms referable to the upper abdomen tend to disappear and are replaced by pain and tenderness over the appendix or as the pelvis fills with this material, later still pain and tender-

ness over the left lower abdomen. In the case of a ruptured hollow viscus the stage of remission is brief, soon the pulse begins again to mount, the belly to slowly distend, the pain and tenderness to become more diffused and difficult to exactly localize, the rigidity to be less localized, in fact, the picture of rapidly developing general peritonitis accompanies the entrance of the patient to the third stage peritonitis.

In but few surgical emergencies is time so vital a factor as in this one. The earlier the "blow out" in the intestinal tube is closed the better the hope for recovery. Statistics have been compiled to show that the mortality is negligible if operation is done within ten hours of the onset of symptoms and that mortality increases thereafter at a rapid rate. Thirty-six hours after onset operative mortality is very high. To diagnose an acute abdomen as ruptured duodenal ulcer, to convince the patient and perhaps his relatives of the necessity for immediate surgery, to transfer the patient to hospital and to have the hole in the gut closed all within ten hours, requires an alert clinician and good team work. When such decisions are made on a battleship at sea, when the medical officer of a ship must ask the Captain to hold up the military activities of his ship or perhaps ask him to leave the line during manœuvres, approach the hospital ship and transport such a patient to the

hospital ship for operation, he must be sure of his clinical findings. The captain of the ship and perhaps the admiral are going to ask later whether the need of the patient was really as acute as represented. A failure to recommend speedy action may mean death to the patient. A few hours' delay for a case of acute appendicitis which has not ruptured, not infrequently is reasonable when a ship is busy at sea, but such a delay in the presence of an acute abdominal catastrophe may prove fatal. Captains of these ships must be shown that the need is real and that speed is imperative. The time between onset and operation in the eight cases in this series was under ten hours, except in one case, in which it was twenty-two hours. These ship's medical officers were on the job. They had the courage of their convictions; their diagnoses were correct. Without such alert clinicians on our ships the record of 100 per cent recovery in these eight cases could not have been made.

Fortunately the clinical picture is usually definite and convincing, but there are cases in which the symptoms are not so striking and conclusive. Age, concurrent pathology, a slow instead of a rapid leak of duodenal contents or other factors, may blur the picture and make the decision for immediate surgery less easy to reach. In those cases where an element of doubt enters, we have searched for some sign to help sharpen the picture. The text-books speak of the loss of liver dulness which is present in this condition when gas from the stomach or duodenum has flowed out and come to lie between the diaphragm and the liver. To wait for such a sign to appear would be wrong and might prove fatal. We have found that diminished liver dulness has been reported by one clinician and the finding denied by another in the same case. There must be a considerable amount of free gas in the peritoneum for this sign to be present. It occurred to our roentgenologist that the X-ray might help in these cases and it has been our experience that it does. An amount of gas too small to reveal its presence by percussion will show with unmistakable clearness on an X-ray plate. When found by X-ray its presence has been verified at operation by the sound of gas escaping from the peritoneum when first nicked by the surgeon's knife. This X-ray finding is not always present and its absence should not lead to a denial of the existence of perforated ulcer. It would not be right to delay operation to obtain this corroborative evidence. Whenever a patient with acute abdomen is admitted, we now take him into the X-ray room enroute to the ward or take such a patient to the X-ray room when he is enroute to the operating room. This does not delay the progress of the surgeon toward his goal of immediate surgical relief. In one of our cases the positive X-ray finding speeded up the moment of decision. This X-ray sign is especially valuable when the patient is first seen in the stage of reaction or at the very beginning of the onset of his peritonitis. It may help the surgeon to distinguish between the acute perforated appendix and the perforated ulcer and thereby shorten the search on the operating table for the cause of the difficulty. Pictures are taken with the patient on his face and with the patient on his left side. Objections

may be raised to this on the ground that such movements may disseminate the escaping stomach content. Perhaps it does, but we fear every moment of unnecessary delay more than we fear this theoretical danger. It is a matter of but a few moments after the taking of the plate before the roentgenologist can report a positive or a negative finding.

The conduct of the operation is simple, localization of the perforation, suture with chromic gut or silk, reinforcement with omental tags. We remove some of the green-colored, cloudy peritoneal exudate with the gauze packs used to isolate the perforation during the time of suture, but do not try to mop all of the fluid out. We do not believe that gastro-enterostomy should be done unless pyloric obstruction is present or is brought about by the necessities of the suture of the opening. We do not drain unless more than twenty-four hours have elapsed since the onset.

Recovery from the emergency of perforation is all that can be reported in this series. We do not know whether or not these patients have or are to have a recurrence of ulcer symptoms. We do know that all of them have been returned to duty in the Navy and it is believed their hope of recovery from a later operation, if necessary, will be greater at a time when the peritoneum is not laboring with the result of contamination than it would be if, as a routine, gastro-enterostomy with or without resection were practiced at the same operation as the closure of the hole in the gut.

In Conclusion—Eight cases of perforated ulcer of the duodenum, diagnosed on naval vessels afloat, are reported. All but one were operated upon within ten hours of onset and all recovered. An X-ray finding in these cases is reported which is believed to be of more value when found than the usually unsuccessful search for diminished liver dulness.

CASE REPORTS

CASE I—No 8546, M C F, Seaman, first class, U S Navy, age twenty-one years. Admitted November 2, 1925, from USS *Relief*. Diagnosed ulcer duodenum.

Past History—An indefinite history of epigastric pain, present at variable and irregular intervals for a period of ten years, not a good history of ulcer.

Present History—Four and one-half hours before admission to USS *Relief* he was taken suddenly with a severe cutting pain in the epigastrium. It doubled him up, an opiate did not relieve the pain. Examination showed him to be in moderate shock with the facies of pain, the entire abdomen was hard like a board. There was tenderness in the right upper quadrant. Leucocytes, 26,900, Polymorphonuclears, 94 per cent, temperature, 100.8, pulse, 88, respiration, 28.

Operation—Appendectomy and suture of perforated ulcer of first portion of duodenum was followed by rapid recovery.

Discussion—No X-ray was taken in this case because it had not at this time occurred to the roentgenologist that free gas in the peritoneum might be found in these cases. (Cottle)

CASE II—No 9001, L L J, Private, USMC, age twenty-one years. Admitted January 31, 1926 from USS *West Virginia* six days after operation for ruptured duodenal ulcer. Operation performed by medical officer of his own ship. Data in detail not available. Recovery. (Shepard)

CASE III—No 9665, J F, Seaman, second class, U S Navy, age nineteen years. Admitted April 10, 1926 from USS *Nevada*. Diagnosed—Ulcer duodenum.

X-RAY IN PERFORATED DUODENAL ULCER

Past History—History of ulcer duodenum diagnosed eight months ago and then confirmed by X-ray

Present History—Five hours before admission to USS *Relief* he was taken with a sudden severe upper abdominal pain Vomited several times

Examination showed moderate shock, a board-like abdominal rigidity most marked upper right quadrant where there was also extreme tenderness Leucocytes, 24,450, polymorphonuclears, 85 per cent, temperature, 98, pulse, 98, respiration, 18 X-ray positive for air between liver and diaphragm

Operation disclosed ulcer perforated in same site formerly diagnosed by X-ray Rapid recovery (Cottle)

CASE IV—No 10675 P J Seaman, second class, U S Navy, age twenty-one years Admitted April 16, 1926 from USS *New Mexico* Diagnosed—Appendicitis acute

Past History—Negative No indigestion

Present History—Two days before admission to USS *Relief* he had a severe pain in the upper abdomen and vomited once The day following this abdomen was tender and pain continued but seemed difficult to localize Examination showed abdomen to be slightly distended and there was generalized abdominal tenderness and rigidity Rectal examination showed more tenderness to the right than to the left Leucocytes, 22,400, polymorphonuclears, 90 per cent, temperature, 100, pulse, 98, respiration 20 Pre-operative diagnosis was made Ruptured appendix versus ruptured duodenal ulcer

Discussion—Unfortunately in this case an X-ray to show presence or absence of air in the peritoneum was not done though it might have proven the diagnosis instead of leaving it in doubt Here operation disclosed a normal appendix bathed in sero-pus After appendectomy the right rectus incision was extended upward and the perforated duodenal ulcer sutured in the usual manner From this history it is impossible to state how much time elapsed after the actual perforation occurred before operation was performed but it was probably not the full period given in the history, i.e. nearly forty-eight hours It is in just this type of case that the X-ray showing free air in the peritoneum may at times be of great value (Boone)

CASE V—No 10,788, B A S Torpedoman, first class, U S Navy, age twenty-eight years Admitted August 14, 1926 from USS *Petrel* Diagnosed—Appendicitis, acute

Past History—Negative except for attack of acute indigestion ten years ago and again six weeks ago a three-hour attack of generalized abdominal pain, since which time there has been bloating and an indefinite epigastric pain most felt at night

Present History—Four hours before admission to USS *Relief* he was taken while at work on his ship with pain in upper abdomen It did not double him up and for an hour he continued at work There was no vomiting at any time Examination showed tenderness over McBurney's point and rigidity of right abdomen and hypochondrium Leucocytes, 16,750, polymorphonuclears, 78 per cent, temperature, 99.2, pulse, 90, respiration, 18

Operation—Through a McBurney incision local anæsthesia permitted the removal of a normal appendix bathed in a greenish-yellow, cloudy peritoneal exudate A second incision high right rectus disclosed the pathology one-eighth inch hole in the first portion of the duodenum close to the pyloric ring

Discussion—The absence of shock and the low pulse and leucocyte counts led all away from the history of antecedent stomach trouble In this case an ante-operative X-ray, which unfortunately was not taken, might have made possible a direct attack upon the pathology without the appendectomy which was unnecessary to effect a cure (Cottle)

CASE VI—No 11,373, B B C, Fireman, second class, U S Navy, age twenty-four years Admitted October 22, 1926, from USS *Arizona* Diagnosed—Ulcer duodenum

Past History—A typical ulcer story of two years duration

Present History—At 7 A M he went on watch but at 7 30 A M a severe pain in the abdomen doubled him up and as he said "dropped him" Two and one-quarter grams of morphine did not seem to have any beneficial effect At 10 A M two and one-half hours after onset he was admitted to the USS *Relief* suffering intense right upper abdominal pain The abdomen was hard as a board and extremely tender, most marked on the right side Leucocytes, 11,500, polymorphonuclears, 88 per cent, temperature, 100, pulse, 110, respiration, 24 On the way to the operating room an X-ray plate was taken which showed "air beneath right diaphragm also air about the right kidney and duodenal area"

Discussion—In this case the X-ray though corroborative was not needed to make the diagnosis which operation corroborated Suture of the "blow out" began a rapid recovery (Joldersma)

CASE VII—No 11,412, L W L, Lieutenant-Commander, U S Navy, age thirty-nine years Admitted October 27, 1926 Diagnosis undetermined (gall-stones), from USS *Arizona*

Past History—Fair for ulcer or gall-stone colic extending back for one and one-half years Barium series and other tests made about one year ago failed to reveal presence of an ulcer and diet directed at control of cholecystitis resulted in a definite remission of symptoms till about ten days ago when stomach distress, belching and sour eructations reappeared after what he considered a mild indiscretion in diet

Present History—At 11 A M five hours before admission to the USS *Relief* he was taken with a severe pain in the right epigastrium which radiated to the right shoulder He was nauseated and the pain caused him to sweat Examination showed him to be in moderate shock, abdomen rigid, most marked on right side, but almost board-like all over Tenderness was definitely located over the gall-bladder Leucocytes, 20,250, polymorphonuclears, 92 per cent, temperature, 99.8, pulse, 104, respiration, 24 After a severe attack of vomiting (5 times) coffee ground material which in the laboratory was said to be altered blood, he entered the stage of remission and felt so much better that he refused operation in spite of the fact that he was told that he had a perforated ulcer and that delay too long would mean death An X-ray plate taken in the hope that it might convince him of the need for operation was negative for free gas in the peritoneum The twenty-second hour after onset he consented to operation and though contamination was extensive and even the pelvis overflowing with the green yellow cloudy peritoneal exudate he fortunately recovered This case was drained for forty-eight hours because of the time which had elapsed after perforation had occurred (Cottle)

CASE VIII—No 11,492, B J T, Aviation Chief Machinist's Mate, U S Navy, age twenty-nine years Admitted October 16, 1926, from USS *Colorado* Diagnosis undetermined (acute abdomen)

Past History—A good ulcer history duration two years

Present History—About four and one-half hours before admission to the USS *Relief* while at work on deck he was suddenly taken with a sharp knife-like stabbing pain in right upper abdomen He had to lie down He became nauseated, broke out in a cold sweat and was taken by his shipmates to the sick bay Examination showed a board-like abdomen with acute tenderness in the epigastrium Temperature, 100.8, pulse 88, respiration, 28 Leucocytes, 13,250, polymorphonuclears, 85 per cent, X-ray showed "air between the diaphragm and liver"

Discussion—The X-ray corroborated the diagnosis tentatively made on the clinical picture Gas escaped from the peritoneum when nicked and the ulcer was infolded as in the other cases of this series (Cottle)

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held October 27, 1926

The President, DR WALTON MARTIN, in the Chair

MELANOMA OF THE LOWER EXTREMITY

DR NATHAN W GREEN presented an adult woman, who was admitted to St Luke's Hospital, July 6, 1920, on account of a growth on the inner side of the left foot. One year ago she injured a mole which she had had all her life. Six months later the growth began to increase in size and it began to pain three weeks before admission. Physical examination revealed a small dark-colored growth on the inner side of her left foot.

July 7, 1920, Dr Nathan W Green, under gas and ether anæsthesia, made a wide excision, lifting up the edge of the skin with forceps and cutting the trabeculæ of areolar tissue with a sharp knife, not at any time touching nor pinching nor pressing the growth. A Thiersch skin grafting was done immediately.

Pathological Report—From the Laboratory of Dr Francis Carter Wood. The specimen consisted of a flat piece of tissue from the heel, measuring 8x6 cm and about 1.5 cm thick. In the centre was a blackish area from which the epithelium was largely denuded. On section this showed a thin but continuous layer of tumor tissue which penetrated the fat only to a slight degree. The deep surface being apparently normal. The tumor tissue was fairly firm and very deeply pigmented.

On microscopical examination the sections from the tumor taken from various portions showed a rather extensive growth involving chiefly the subcutaneous tissue. This spread widely through it, forming a rather narrow and diffuse band of tumor tissue in the upper portion of the excised area. The growth itself seemed to consist of spindle-shaped cells with a tendency to grow in rather loose alveoli or to infiltrate the fibrous tissue. It extended well up into the epithelial layers, even displacing the basal cells. Many of these tumor cells were deeply pigmented with a golden brown or greenish intracellular granular pigment. The deep border in all the sections appeared normal.

The patient was discharged on August 6, 1920. To-day, October 27, 1926, six years after her operation, she appears clinically free of malignancy.

DOCTOR GREEN added further that he had a personal communication from Dr Robert T Morris stating that he had had a similar experience wherein the patient went over six years after removal without apparent malignancy and finally developed metastases of the liver. He had referred this case to Doctor Coley. Doctor Green said that he made a wide incision at a good distance from the pigmented area and lifted up the skin edge and put the trabeculæ of areolar tissue on the stretch and cut this as near the deep fascia as possible with a sharp knife. In this way it was less disturbing to the growth and there was less danger of dislodging tumor cells into the circulation.

LONG-STANDING RECOVERY FROM PYLORIC OBSTRUCTION SIMULATING CANCER AFTER A PALLIATIVE GASTRO-ENTEROSTOMY

DR NAATHAN W GREEN presented a man, fifty-six years of age, who was admitted to the Memorial Hospital, February 6, 1922. His present illness dates from November, 1921, since which time he lost about thirty pounds in weight. At that time a dull pressing pain was felt about the epigastrium about one and one-half to two hours after eating, which was somewhat relieved by vomiting. Pain and vomiting persisted after each meal until about one month ago, when a steady dull pain was felt in the epigastric region, radiating to the back and sides. He was unable to retain food, and had kept on fluids up to the time of admission.

On physical examination there was found marked tenderness all about the epigastric region. A small soft nodule was felt in the midline of the epigastrium, probably a fat hernia (epigastric hernia). No definite tumor mass was palpable. The liver was not palpable, and there was no cervical adenopathy.

He was admitted with a provisional diagnosis of carcinoma of the stomach, which was arrived at by a fluoroscopic examination made a few days before admission by Doctor Herendeen, which revealed what appeared to be a small annular prepyloric carcinoma. February 1, 1922, just before admission, there was an indefinite mass felt in the right epigastrium.

A diagnosis of carcinoma of the stomach was made and the patient was referred to the Conference. He was recommended for admission by the Conference for a gastro-enterostomy, which was done by Doctor Green, February 10, 1922, under 1 per cent novocaine.

The pathologic findings revealed an indurated mass which was attached to the posterior abdominal wall. There was no invasion noted of the surface of the prepyloric area. The tendency was to bend the stomach backward in the region of the pylorus. This backward bending of the stomach and adherence of the pylorus evidently was causing the obstruction. A posterior gastro-jejunostomy was quickly done and on account of the weakness of the patient no specimen was taken for biopsy. He made a steady recovery and, May 25, 1922, he was released from the Social Service and went to the Catskills.

December 14, 1923, a note made by Doctor Herendeen stated that X-ray examination revealed the presence of a large annular carcinoma of the prepyloric segment. The gastro-enterostomy stoma seemed involved as there was considerable retention at six hours. The picture of this condition is attached herewith (Fig 1).

March 1, 1926, he complained of burning and did not look well.

February 2, 1926, a note from Doctor Herendeen's laboratory stated that the annular deformity of the antrum was clearly shown and the larger part



FIG 1.—Taken December 1923 shows what appeared to be a filling defect and some delay in emptying by the stomach.

LONG-STANDING RECOVERY FROM PYLORIC OBSTRUCTION

of the stomach appeared normal, and that barium was leaving through the enterostomy opening, and at six hours practically none was left

In the fall of 1926 the patient was improved and had a good appetite. An X-ray taken at this time is shown for comparison in Fig 2. His weight in October, 1926, was 102½ pounds, whereas on December 12, 1923, when X-ray No 1 was taken, it was 123½ pounds. He has worked ever since the spring of 1922 with occasional days off.

The patient was shown as a case in which a diagnosis of carcinoma of the stomach was reasonable and this was corroborated by the X-ray. But in view of the later course of the case the question of diagnosis has been placed in doubt and very properly. Also it shows that although a patient may present the picture of an advanced and inoperable carcinoma, it is justifiable to give him the benefit of the doubt, and do in selected cases a palliative operation. This man has gone nearly five years since his gastro-enterostomy.

DR GEORGE WOOLSEY remarked that he did not see how a positive diagnosis could be made simply from the X-ray and the history. Where a tumor mass showed in the X-ray in this situation, he had been unable in a few cases, even when the mass is exposed, to make a diagnosis. A good many years ago he explored a stomach case, making a diagnosis of carcinoma and doing a gastro-enterostomy. Two years later he saw the man. He had gained forty pounds in weight. Twelve or thirteen years later he heard of him in perfect health. He did not think one could make a positive diagnosis from the X-ray alone, in early cases.



FIG 2 —Taken in the fall of 1926, still shows what appeared to be a filling defect much the same as in Fig 1. The diagnosis of carcinoma is by this placed in doubt.

DR RICHARD LEWISOHN agreed that at the time of operation an ulcer was present near the pylorus. It is very difficult to say whether it had transformed into a carcinoma in the interval. He suggested that the patient should be operated again, as he may still suffer from an old ulcer which should be removed in order to prevent subsequent malignant degeneration. If malignancy had been superimposed on the old ulcer, an attempt at radical removal of the carcinoma should be made.

DOCTOR GREEN rejoined that he did not think anyone should be content to make a diagnosis by X-ray alone, as it was merely a shadow, although in the majority of cases the X-ray gave very good corroborative evidence taken together with other factors. In this case, the patient had got along so well that he was in doubt whether his original diagnosis was right. The

patient was presented as an illustration of what may eventuate when a palliative gastro-enterostomy has been done for what appeared to be a case, moribund from gastric cancer. He would be unwilling to resect the stomach in this frail old gentleman. He thought he had already had a pretty fair lease of life. Comparison of the two gastric pictures two and a half years apart showed but slight change in the contour.

EPITHELIOMA OF THE PENIS

DR NATHAN W. GREEN presented a man, about fifty-four years of age, who was admitted to St. Luke's Hospital, July 15, 1924. About six months previous to admission he noticed itching of the head of the penis. He treated it with some salve and was relieved. About three months previous to his admission he felt a little hard area like a white wart. June 28 he noticed intense stinging in the penis which prevented him from sleeping. On examination a red mass was found about the size of a medium-sized pea, in addition to the "white wart." The reddish area bled a little at times. His previous history and family history was irrelevant.

On examination there were found two small growths on the dorsum of the penis near the glans. Each was about the size of a dime, one appeared papillomatous and the other like a strawberry. The inguinal nodes were not enlarged. There was slight induration around the growths. The Wassermann was negative.

July 18, 1924, Dr. Nathan W. Green circumcised the man and excised the growths.

July 18, 1924, a diagnosis of epithelioma was made by Doctor Knox, after microscopical examination. The sections of the specimen showed it to be a very extensive type of epithelial growth which is now infiltrating and morphologically malignant. There were many large solid masses of epithelial cells in which differentiation was fairly complete, but the basal layers appeared to be very much more actively growing. It contained many mitoses, and the basement membrane was not intact. The growth was, however, fairly superficial, but was extremely vascular. There were many pearls throughout.

July 29, 1924, dissection of the left inguinal nodes was done. This specimen showed chronic adenitis (inguinal) but no metastases.

August 8, 1924, dissection of the right inguinal and femoral glands was done. This specimen showed chronic adenitis (femoral and inguinal), no tumor cells were found.

Between September 29, 1924, and March 3, 1925, the patient was submitted to nine X-ray séances in Dr. Francis C. Wood's Department. Raying the right or left inguinal region alternatively for from fifteen to twenty minutes with a rather low voltage tube and filtered through aluminum.

The patient was readmitted, March 23, 1925, with what was feared to be a local recurrence. The remaining foreskin did not retract over the corona. On the anterior surface of the penis, just behind the glans, there was a slightly thickened, indurated area. Apparently extending into the corpus cavernosum. The foreskin was redundant and somewhat adherent to the glans.

March 26, 1925, by a circular incision, the thickened area was excised, extending deeply into the corpus cavernosum and glans almost to the wall of the urethra, but this specimen showed only chronic balanitis.

Microscopical examination made by Dr. L. C. Knox reported that the sections showed skin, together with subcutaneous tissue and small, dilated, thick-walled vessels. There was a chronic inflammation of the skin itself with

ENTAMÆBIC ABSCESS OF TRANSVERSE COLON

extensive infiltration in the epithelial layer and beneath it. Polymorphonuclear cells, plasma cells and round cells were also present. This infiltration extended inward along the vessels and the nerves. The epithelium showed very light hypertrophy in some areas, but there was no evidence of malignancy (That is, there was no recurrence.)

From August 11, 1925, to October 19, 1926, the patient has again been subjected to radiotherapy, having been given nine treatments alternating on either side. He now appears free from malignancy and is in good nutrition, attending to his work every day. He was presented to illustrate a procedure where the organs had been spared and where the devastating operation of total ablation had not been done and so far, well over two years, there had been no recurrence of malignancy.

ENTAMÆBIC ABSCESS OF TRANSVERSE COLON

DR EUGENE H. POOL presented a man, twenty-nine years of age, who was admitted in October, 1925, to the New York Hospital. He had been in hospital two years before with a diagnosis of chronic colitis. Proctoscopic examination at that time showed several bleeding ulcers. Barium enema was negative. After leaving hospital he was quite well, except for intermittent diarrhoea. Fifteen days before recent admission he noticed tenderness to the left of the umbilicus. This tenderness increased but he had no actual pain. He had no bloody stools and had not lost weight. Patient is a sailor and has been to South America and Africa.

Physical Examination—A fairly well-developed, rather poorly nourished man, appearing chronically ill. Examination of abdomen showed definite spasm of muscles in region of umbilicus, where a mass was palpable to the left of the umbilicus. Surface was slightly irregular, firm and quite tender. Urine negative, white blood-cells 21,000, polymorphonuclears 58 per cent, lymphocytes 19, transitionals 11, eosinophiles 12 per cent, stools—red blood-cells.

X-ray—Enema showed no obstruction but marked kinking and spasm in transverse colon.

Patient was explored November 2, 1925, and a first-stage Mikulicz operation performed. A mass involving the transverse colon was found. The mass was about five inches in diameter and to it was attached the omentum. On the under surface were adherent two loops of small intestine. The lymph-nodes were generally enlarged, even on the greater curvature. The whole mass could be lifted out of the abdomen, and it seemed wise to do a first-stage Mikulicz as no nodules were felt in the liver. A lymph-node was removed for microscopic examination. The two loops of small intestine were freed, and the whole mass then lifted out of the abdomen, and the cæcum sutured to the distal part of the transverse colon. The first day post-operative patient was given a transfusion of 500 c.c. of blood.

On the second day a tube was introduced and sutured. Seven days later the specimen was removed after clamping the intestine and cutting between clamps, and ligating the meso-colon. The specimen removed showed a large intestine with mucous surface covered with small projections about 2 cm. in diameter, suggesting small polypi. There was a dense ring 1.5 cm. in diameter where the intestine had perforated, communicating with an abscess cavity containing pus and necrotic tissue. Three days later, redundant intestine was excised with knife and cautery. Into the proximal limb a suction tip was inserted and maintained with one silk suture. Four days later patient was given another blood transfusion of 500 c.c.

Pathological Report—1 Node shows an enormous increase in the number of lymph follicles with dilated lymph channels.

2 Large mass 23 by 20 cm Microscopic examination shows the lesions of amebic colitis Amebæ found in the pus

3 Three specimens of bile in Boun's fluid obtained by duodenal tube and stimulation by 50 per cent magnesium sulphate solution Section of hardened sediment in paraffin shows many pus cells with detritus and occasional epithelial cells A few cells suspicious of encysted amebæ (dysentery) were found after careful search

4 Three specimens of bile in Boun's fluid obtained by duodenal tube and stimulation by 5 per cent sodium taurocholate solution Section of hardened centrifuged sediment of three bile specimens show occasional pus and epithelial cells, but no entamoebæ dysentericæ (January 12)

Soon after the second-stage Mikulicz treatment was begun It consisted in subcutaneous injections of emetine hydrochloride, later stovarsol and bid irrigations of silver nitrate solution (1/1500 to 1/1000) February 15 (105 days after original operation) the colostomy wound was closed An appendectomy was done and a No 20 French catheter was inserted in the appendix stump Fistula healed without leakage and in eight days cecostomy tube was removed

Follow-up Report—June 6, 1926 Patient returned to work one month after discharge and continued at work every day since Bowel's regular Appetite good Has gained ten pounds No diarrhoea No pain Feels well Physical examination Condition excellent, small hernia at upper end of his incision

CLOSURE OF ABSCESS OF LUNG BY MUSCLE TRANSPLANT

DR EUGENE H POOL presented a man, aged twenty-six years, who was first admitted to the medical ward of the New York Hospital in August

1911, with a diagnosis of incipient tuberculosis He had physical signs on the left apex but sputum was negative His tonsils were removed soon after this His second admission was in January, 1926, with a diagnosis of lung abscess He was operated upon February 4 by incision and drainage of the abscess Under local anæsthesia two inches of two ribs were removed high in the right axilla The abscess was opened and considerable thick pus evacuated Two rubber tubes were

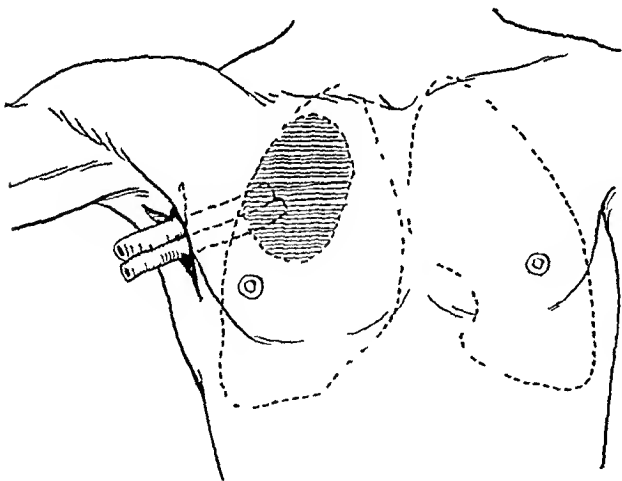


FIG 1 —Drainage of abscess

introduced (Fig 1) His convalescence was good His sputum was negative for tuberculosis He was again admitted April 1, 1926, with a persistent sinus X-ray after lipiodol injection into the sinus showed communication with a bronchus (Fig 2)

Laboratory Reports—February 9, 1926 Specimen, at time draining from abscess, consists of mass of necrotic tissue Microscopic examination reveals a mass resembling mycelia with clear spore-like bodies Occasionally branched forms appear These masses resemble some form of higher bacteria, possibly aspergillus nodularis April 22, 1926, Autopsy of guinea pig

CLOSURE OF ABSCESS OF LUNG BY MUSCLE TRANSPLANT

injected with 2 c c of pus from lung abscess February 11, 1926, showed no lesions February 20, 1926, cultures from the wound exudate show staphylo-

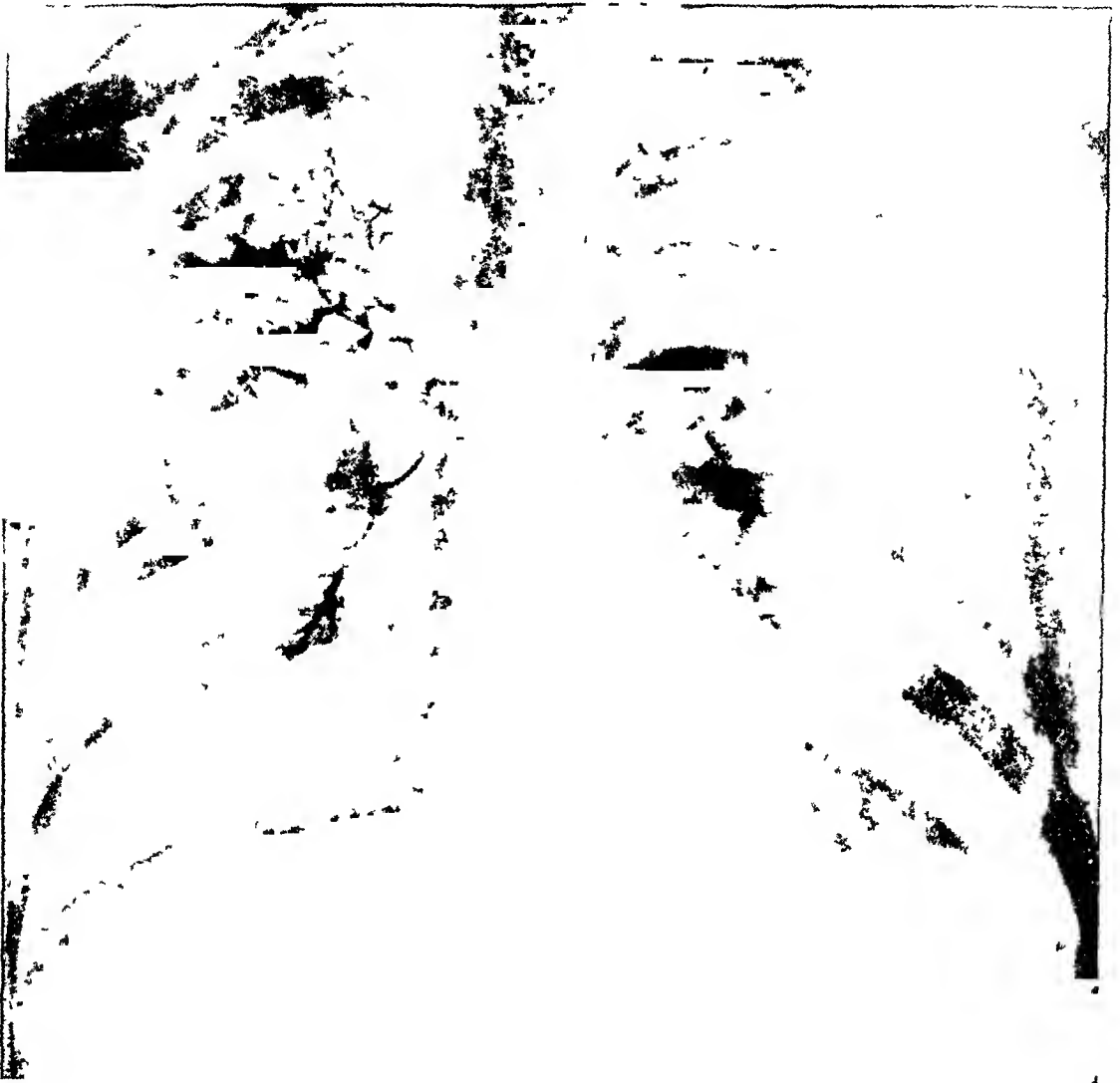


FIG 2 —Result of lipiodol injection into chest sinus

coccus aureus as the predominating organism with a few colonies of non-hæmolytic streptococcus No higher bacteria, pathogenic yeasts or molds Sputum examination—January 20, 21, and 22, 1926, negative for tuberculosis

May 3, 1926, operation for closure of bronchial fistula Skin around the sinus excised New-formed bone around the opening into the thorax excised The cavity was about the length of the index finger Its walls were soft and friable and the cavity was about 2 cm in diameter The incision was extended along the lower

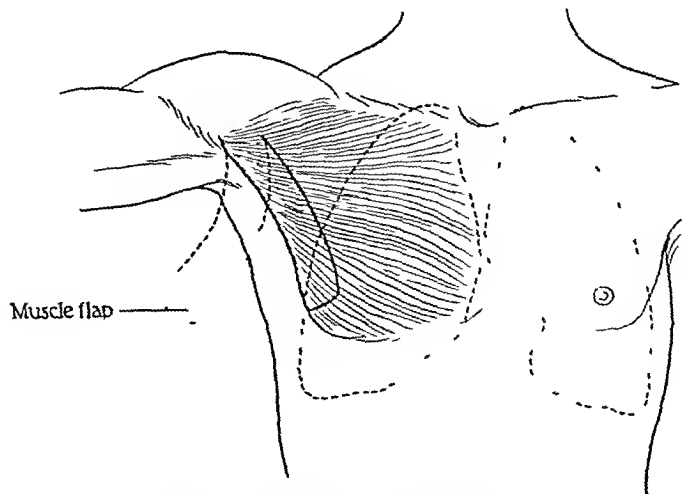


FIG 3 —Formation of muscle flap

margin of the pectoralis major and lower part was dissected free. A strip of muscle about twice as thick as the cavity and about four and a half inches long was dissected, leaving its outer end attached. This was a pedunculated flap (Fig 3). The strip was then turned into the cavity and fixed by two

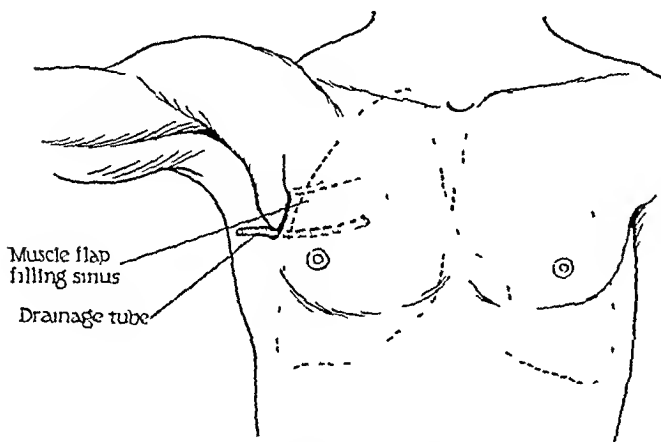


FIG 4—Muscle flap transplanted

chronic sutures at the outlet of the cavity. A small rubber tube was placed along this strip to the bottom of the cavity to prevent a collection. Wound was sutured, except the central part, which was packed with gauze (Fig 4). Ether and ethylene anaesthesia. Time, twenty-eight minutes. There was no cough after operation and the wound rapidly healed.

October 13, 1926. Weight, 154 pounds, gain of 35 pounds since operation. Is feeling fine, no complaints. Is working. X-ray shows no abnormality at site of cavity.

ADENOCARCINOMA OF THE APPENDIX

DR. FREDERIC W. BANCROFT presented a man, aged thirty-three years, who on the evening of January 18, 1926, developed an attack of general abdominal pain more marked in the right lower quadrant. He vomited several times. He took a cathartic and immediately vomited. An enema caused a fair bowel movement. Patient was examined by his family physician at 1 A.M. and a diagnosis of acute appendicitis was made. He was given a medicated enema which returned clear. His pain increased and finally localized in the right iliac fossa. At 6 A.M. he was sent to the hospital. On admission to the hospital his urine was negative. His blood count was 16,000 leucocytes with 81 per cent polymorphonuclear. Temperature 99.5°, pulse 108. Examination showed no distention. There was rigidity of the right rectus and tenderness at McBurney's point. At 8 A.M. there was also some pain and tenderness in the region of epigastrium. He was immediately taken to the operating room. A right rectus incision was made. On inspecting the caecal region a large tumor was found retrocaecal and apparently occluding the ileum at the ileocaecal junction. The small intestine was isolated from the semi-solid material. As the patient's condition was poor and there was considerable distention, it seemed inadvisable to do a complete operation at this time. Therefore, a lateral anastomosis was performed between the ileum at about a foot from the ileocaecal junction and the transverse colon. A small piece of the tumor was removed for examination and wound closed.

The report of the tissue excised was adenocarcinoma, apparently of the appendix. Patient did well following this procedure save that the abdominal wound became infected.

The second stage was performed February 18. At this time the tumor, the terminal ileum and the ascending colon up to the anastomosis, was excised. Considerable difficulty was found in freeing the tumor from the lateral abdominal wall. The ends of the ileum and transverse colon were doubly inverted and rubber dam drain inserted. Wound closed. His convalescence was uneventful.

RECURRENT OBSTRUCTION OF COMMON BILE DUCT

The pathological report of the specimen removed showed it to be adenocarcinoma of the appendix invaginated into the terminal end of the cæcum and ileum.

He presented this case first because it was an unusual tumor which caused an obstruction, although the symptoms were suggestive of acute appendicitis. Second, a two-stage operation with obstruction is sometimes preferable from the point of safety of the patient to a complete excision and anastomosis at one stage.

DR NATHAN W GREEN remarked that the patient was a young man. It seemed to him that surgeons were observing a number of this type of cases and that this type of case was evolving itself into a definite entity—carcinoma of the ileocæcal region in comparatively young persons. He had a similar case in a rather young woman in which he had resected the cæcum and ascending colon and part of ileum in a similar manner. At that time she had enlarged glands in the mesentery, which however did not show tumor cells. She lived in good health for five years; then she drank by mistake some lysol. He saw her in the hospital in a medical ward, but shortly afterward lost track of her.

RECURRENT OBSTRUCTION OF COMMON BILE DUCT BY BLOOD CLOT

DR FREDERIC W BANCROFT presented a man, aged thirty-four years, who on June 10, 1926, developed pain in right hypochondrium, radiating to right shoulder and back. Had extreme difficulty in getting breath. Pain was cramp-like in character. Three days after onset of illness patient became jaundiced. Jaundice continued with occasional attacks of pain until his operation June 16, 1926. At admission to the hospital, clotting time three minutes, bleeding time four minutes. Was given calcium lactate by mouth for twenty-four hours ante-operative.

At operation the gall-bladder, filled with stones, was removed, the common duct opened and several stones removed from it. The operator, after convincing himself that there were no stones in the duct, introduced a rubber tube and sutured the wound in layers. Patient did perfectly well until the eighth day post-operative, when there was some oozing noticed on the dressing. On the ninth day he had a chill associated with an attack of intense pain in the back, which at first was suggestive of a pulmonary infarct. On the tenth day patient was slightly jaundiced with a bloody ooze from the wound with no sign of any bile. Patient appeared acutely ill, vomited some blood, and passed tarry stools. On the eleventh day was taken to the operating room and transfused with 500 c.c. by the Unger method. On account of the blood appearing in the stools and the blood oozing from the wound, and the signs of obstruction of the common duct, a provisional diagnosis of a blood clot occlusion of the common duct was made. The drainage tract was slightly enlarged, and a finger inserted into the wound. With fingers and sponge forceps a large blood clot was removed. Blood clot showed a mould of the common duct about two inches in length. Following removal of the clot, bile escaped. A drainage tube was inserted. Following this the patient did fairly well for two days, but on the third day again had an attack of acute pain, chill, rise in temperature associated with a bloody discharge from the wound and cessation of the bile flow. Patient was again taken to the operating room, anaesthetized and wound opened widely. Another firm clot showing mould of the common duct was removed. A bleeding point which was apparently in the stump of the cystic artery was ligated and a tube again

re-inserted in the common duct Bile escaped from the duct after the removal of the clot Patient was given sodium chloride intravenously following this operation Convalescence was uneventful and the patient left the hospital in about three weeks.

DR GEORGE WOOLSEY said he thought this a rather unusual complication of gall-bladder surgery In a paper about six years ago, he reported an experience of his own some years ago where a man had been operated on twice for gall-stones, the second time to close a persistent fistula The second operation was not successful, so that about eight months after the first operation, when he first saw him, he was still draining all his bile through the fistula Doctor Woolsey found a stone in the common duct, as expected, and a group of stones well up in the hepatic duct, in a pocket on the surface of the liver. He had to use a little force to dilate the duct with the finger enough to move these stones He put in a tube as usual, and during the first twenty-four hours blood began to ooze from the tube This bleeding did not amount to very much but he soon became jaundiced A suction was used with the tube, later removing the tube and applying the suction to the opening, without any effect In the meantime the jaundice deepened, the temperature rose and there were some chills On the fourth day a little bile began to appear in the wound and this increased every day, so that in about a week he was draining a good deal of bile, and there was a good deal of bile in the stools The man made a complete recovery

MALIGNANT TUMORS OF THE THYROID

DR EUGENE H POOL read a paper with the above title, for which see vol lxxxv, page 120

DR ALEXIS V MOSCHCOWITZ said that a number of years ago he stated that there were two kinds of carcinomas of the thyroid glands, one in which the pathologist makes the diagnosis and one in which the surgeon makes the diagnosis In his experience, the first group gives a much better result than the second group, in other words, the early cases of carcinoma give a much better final result than the neglected cases

He was not as a rule a very ardent advocate of X-ray therapy He has had, however, in the last few years, a number of cases in which radio-therapy certainly did wonders He recalled one case particularly which had progressed so far that the carcinomatous process involved both the trachea and the thyroid cartilage, so much indeed, that there was undoubted carcinomatous tissue left attached to this structure The patient received energetic X-ray treatment and up to date, fully three years after operation, is not only alive, but is well Since that time, Doctor Moschcowitz has had other cases, and he was so much impressed by the first case, that he is rather in favor of post-operative radiation in carcinoma of the thyroid gland

DR SEWARD ERDMAN said that in some instances the development of metastasis will prove to be the first indication that carcinoma of the thyroid has existed As an illustration of this fact he cited the case of a man, sixty-one years of age, upon whom he had operated in February, 1925, for a large

PARTIAL RESECTION OF RIGHT LOBE OF LIVER

malignant tumor of the upper abdomen. The abdomen contained blood-stained fluid and there were metastatic nodules distributed over the peritoneal surface. However, the principal mass was found to lie high in the abdomen and was definitely retroperitoneal. The stomach, gall-bladder and intestines nowhere showed evidence of primary involvement. A node taken from the gastrocolic omentum was reported by the pathologist as metastatic adenocarcinoma. This case is of interest because just one year before the exploratory abdominal operation, Dr. John Rogers had operated upon this man, performing a partial thyroidectomy. Six months before Doctor Rogers' operation the man had developed an "abscess" in the right lobe of the thyroid in which region he had had a swelling, probably adenoma, for many years.

The abscess was opened by his physician, drained pus, and had never completely healed. There was a sinus into the thyroid tissue at the time Doctor Rogers operated. The pathologic report on the thyroid tissue discussed the presence of multinuclear, foreign body giant cells and some atypical epithelial cells with colloid goitre in other portions of the gland. No diagnosis of carcinoma of the thyroid was made, but in view of the early development of carcinoma elsewhere one may consider that a small carcinoma of the thyroid was the primary lesion.

DR. BURTON J. LEE said that there was marked variation in the pathology of malignant tumors of the thyroid, those which proved to be of embryonal type were more radio-sensitive than those in which the tumor cells were of adult type. Doctor Craver, of Memorial Hospital, has reported eighty-three cases of thyroid malignancy. One case which came under Doctor Lee's immediate attention, with recurrences in the scar following operation, yielded satisfactorily to low voltage X-ray treatment. This patient still has no evidence of disease, three years after operation.

Stated Meeting Held November 24, 1926

The President, DR. WALTON MARTIN, in the Chair

PARTIAL RESECTION OF RIGHT LOBE OF LIVER FOR HEPATOMA

DR. HERMANN FISCHER presented a specimen and microscopic slides, to which was attached the following history:

About six months ago, while in Florida, a woman began to suffer from weakness, general malaise and fever (101° F). A short time later she noticed a lump in right lower quadrant of her abdomen. This lump was quite movable. She was able to move it from the right lower quadrant upward and back to the right lateral wall. It soon began to grow much larger and patient began to have some pain in the vicinity of the tumor. The pains frequently radiated to the right costal margin and were so severe that she was obliged to go to bed. These pains were very frequent several months ago, but now do not recur unless she remains on her feet for a long time. There are attacks of fever usually in the afternoon or evening. The temperature occasionally goes to $102-103^{\circ}$. Rest in bed usually reduces these attacks of fever. She lost twenty pounds in weight in first four weeks of illness.

Examination showed no evidence of abnormal conditions of the thoracic organs.

On inspecting the abdomen a distinct fulness of the right hypochondriac region could be noticed and on deep respiration a large, round, smooth mass could be seen moving under the abdominal wall from the lower border of the ribs to three fingers' breadth below the umbilicus. On palpation this tumor was smooth, almost round, painful on palpation, especially at its lower border and could be moved toward the median line with perfect freedom. It had an elastic feel, like a cyst containing fluid under pressure. The percussion note was dull and this zone of tumor dulness merged into the liver dulness.

The impression was gathered from the palpatory findings that the growth was most probably with an intraperitoneal intimately connected with the right lobe of the liver.

The *Graham test* showed the gall-bladder distinctly outlined from the large shadow of the tumor, it seemed to be normal, except that it was pushed inward, close toward the spine by the growth.

A *pyelogram* outlined the calyces of the kidney, and except for a slight dilation showed no abnormality. The kidney shadow was also distinct from the large shadow of the tumor in front.

It was therefore assumed that the new growth was situated in the right lobe of the liver. A negative Wassermann test spoke against a gumma of the liver.

At the operation the following condition was found.

A median line incision from ensiform cartilage to umbilicus was made, combined with a transverse incision through the right rectus muscle.

The much enlarged right lobe of the liver was adherent to the transverse colon and omentum. After severing the adhesions this lobe of the liver which was the seat of a tumor the size of a baby's head, could easily be lifted out of the abdomen. The tumor was solitary, soft and of a grayish-white, mottled color. Aspiration revealed no fluid. Its inner border encroached upon the gall-bladder which was normal. Careful exploration of the abdomen showed that no other tumor masses were present.

The gall-bladder which was in close proximity to the tumor was excised first. Two elastic intestinal clamps were then applied above the tumor and carefully closed, tight enough to compress the parenchyma of the organ, enough to prevent hemorrhage without tearing the surface of the liver. The diseased part of the lobe of the liver was then removed with the *Pacquin* cautery. There was no hemorrhage. The cut surface of the liver was seared with the *Pacquin*; the compression of the clamps on the stump was then released somewhat by slightly opening the clamps, after a few seconds some large vessels in the parenchyma started to bleed, each of these was clamped and tied. After all vessels were tied, the clamps were again tightly closed and an interlocking chain suture of chromic gut applied behind the branches of the clamps. The clamps were then removed and no hemorrhage occurred. The outer surface of the liver parenchyma was perfectly dry. Several layers of iodoform gauze were put upon the outer surface of the liver, a small cigarette drain was inserted down to the ligated cystic duct, and the abdominal wound closed, the tampon being led out at the upper angle of the wound.

The patient stood the operation very well.

Her pulse-rate was high for the first five days after the operation, 130-140, but of good quality.

On the third day post-operative patient developed a pneumonia in the left lower lobe which had disappeared after two weeks.

Three weeks after operation the temperature again rose to 102°. Patient complained of pain in liver region.

PARTIAL RESECTION OF RIGHT LOBE OF LIVER

The wound which in the first four days had drained bile profusely had almost closed, but its granulations looked oedematous.

After three days the fistula opened spontaneously and wound drained quite an amount of pus, whereupon the temperature dropped to normal and her pain stopped.

The pathological examination of the specimen showed the following.

Gross Appearance—The specimen consists of a tumor with some liver tissue and a gall-bladder. The tumor which has been split open measures 12 x 10 x 6 cm. The external surface is smooth, slightly reddened and contains a few adhesions. There are many small nodules ranging in size from a marble to a pea on the external surface. The tumor has not broken through the capsule of Glisson, which is markedly thickened over it. On section the tumor is seen to be fairly well localized. At both ends there is a narrow rim of liver tissue. The tumor itself is divided into many lobules by bands of connective tissue. The lobules vary markedly in size, shape and color. Some are soft, somewhat translucent and bile stained. Others are yellow, granular and seem necrotic. In others there are small hemorrhages and deposit of black pigment.

The gall-bladder measures 8 x 3 cm. The external coat has some adhesions, but is not injected. The wall is not thickened. The mucosa is velvety and not injected. *Diagnosis* Hepatoma. Chronic catarrhal cholecystitis.

Microscopical examination of the tumor shows a tumor composed of large polyhedral cells. The cytoplasm of these cells is granular and slightly acidophilic. The nuclei are centrally placed and have a vacuolated appearance. Mitotic figures are not demonstrable. Broad sheets of these cells are surrounded by more or less dense septa of connective tissue. These septa are occasionally infiltrated with round cells. The epithelial cells resemble liver cells very markedly and the structure differs from adjacent liver tissue only in that the cells are not arranged in columns. In the tumor there are a fair number of thin-walled blood-vessels and there are extensive areas of necrosis. The liver tissue surrounding the tumor shows areas of round-cell infiltration. Surrounding the neoplasm is a capsule of rather dense connective tissue in which tumor cells are absent.

Other sections show a gall-bladder in which there is some papillary overgrowth of the mucosa. The submucosa is slightly thickened and congested.

DR DEWITT STETTEN said he had seen the fresh specimen immediately after resection. The tumor had certain definite characteristics. It was soft, more or less encapsulated, and on cut section the tissue was distinctly greenish-yellow in color, suggesting that the tumor was composed of liver cells, actively secreting bile. In a somewhat similar case reported in the Proceedings of the New York Pathological Society, 1921, the patient unfortunately suffered from multiple tumors, and it was only possible to remove one of the tumors for microscopic examination. It was interesting to note that in this case the patient subsequently developed an entirely different form of tumor, namely a squamous-cell epithelioma of the oesophagus for which a gastrotomy was done, which eventually led to the patient's death, and which was demonstrated at the post-mortem examination. It was found that the liver was filled with larger and smaller hepatomatous nodules and that both lungs were invaded by metastases which were of the same character as the primary liver tumor.

PARTIAL RESECTION OF STOMACH FOR CARCINOMA

DR HERMANN FISCHER presented a woman, who about six months ago became very anæmic. Her hæmoglobin fell to 50 per cent. She was transfused, improved after that and discharged.

Later progressive weakness again developed. No vomiting, no pain in stomach, bowels regular, *appetite good, no loss of weight*.

Previous history negative. Mother and grandmother died from cancer of stomach.

Very anæmic, no masses to be felt in the abdomen and no pain whatever on palpation. Blood (before transfusion). 2,390,000, hæmoglobin 40 per cent, after transfusion, 3,180,000, hæmoglobin 50 per cent.

X-ray examination showed a stomach large in size and normal in shape and appearance. There was a very marked, persistent deformity seen in the antral portion of the stomach. It involved both the lesser and greater curvature and extended up to the pylorus. Beyond the pylorus a large, regular cap could be filled.

At the sixth hour there was a fairly marked retention in the stomach and the deformity in its antral portion was accentuated.

The deformity to the stomach, combined with the six-hour retention, strongly suggested the possibility of a new growth in this region.

A median line incision made September 20, 1926, revealed at the lesser curvature of the stomach near the pylorus, a hard indurated tumor about the size of a silver dollar. There was no glandular involvement along the lesser or larger curvature of the stomach.

The liver and gall-bladder seemed to be normal.

Therefore, a subtotal resection was done after Billroth II and Balfour-Polya modification.

The specimen showed an ulcer with a deep crater the size of a quarter, its edges indurated and everted.

Pathological examination showed the ulcer to be a carcinoma.

The patient rallied well after the operation and made an uneventful recovery. Three weeks after operation her hæmoglobin had gone up to 60 per cent.

To-day (November 22), two months after the operation, she feels very well, has gained in weight and strength.

This case was shown as a type in which the difficulty of arriving at an early diagnosis of carcinoma of the stomach is exceedingly great. At the same time it proves the great value of careful X-ray examination.

In this case there were no clinical symptoms at all referable to the stomach, she had a good appetite, no vomiting, no bleeding, no pain, and in spite of this the operation revealed a large carcinomatous ulcer. The only symptom of a serious organic disease was the extreme secondary anæmia from which the patient suffered.

The cause of this condition was only detected by the careful X-ray examination, which alone made the diagnosis possible.

INTRAHEPATIC GALL-STONES

DR HERMANN FISCHER presented a woman, thirty-nine years of age, who was admitted to the Lenox Hill Hospital with the following history.

About fifteen months ago she had a pain in the right upper quadrant which radiated to the back and the right shoulder. These attacks were quite frequent during the last fifteen months. The pains would last from two to four hours and occur at varying intervals. The pain sometimes occurs at night and is aggravated when lying on the right side. In the interval the

CARCINOMA OF STOMACH

patient has a sore feeling and gaseous eructations Her appetite is poor No blood in stool, no vomiting She has lost forty pounds since the onset of her illness No jaundice She sometimes has a chilly sensation with the attacks

Her thoracic organs were normal The abdomen was soft, scaphoid type There is palpable a small mass the size of a plum just to the left of the umbilicus No other masses in abdomen No tenderness X-ray examination of stomach showed no pathology Chemical analysis of stomach contents showed hyperacidity, no blood

Operation—October 2, 1926 Median line incision from ensiform cartilage to umbilicus Stomach and duodenum normal Gall-bladder thickened, contains numerous small stones, one impacted in cystic duct Ectomy

In the right lobe of the liver numerous white and hard nodules are felt and seen near the thin edge of the lobe under Glisson's capsule They are of a whitish color and suggest carcinomatous metastases On closer examination, however, they were found to be of a chalky consistency Some of the nodules were near the surface of the liver, others were deeply imbedded in the parenchyma of the organ As they were massed close together and as no other nodules were found in the liver, a wedge-shaped piece of liver which contained the concretions was resected The defect in the liver was closed by suture Small cigarette drain to cystic duct, closure of wound around drain

The nodules in liver substance are intra-hepatic; stones size of a pea

The macroscopical examination of the section of liver tissue carrying stones shows slight thickening with hyaline degeneration of the capsule The parenchyma shows degenerative changes with localized atrophy of the liver cells There is a thickening of the interlobular fibrous tissue

The chemical examination of the stone showed it to consist essentially of calcium phosphate mixed with some cholesterol The pigments are not present

The other gall-stones from the gall-bladder are the usual cholesterol-bilirubin stones

DR ALLEN O WHIPPLE said that the only case he had ever seen clinically or at the time of operation which was of this nature involved so much of the liver that it was impossible to do anything with it The patient was a Chinaman who had been operated on for gall-stone disease and the gall-bladder had been removed At that time stones had been found in the common duct There was a certain amount of detritus which Doctor Whipple considered as indicating a bad prognosis The strange part of the case was that this patient did fairly well after this operation, the jaundice clearing up Four months later, however, he came back to the hospital deeply jaundiced At operation it was found that there were many stones and soft detritus in the common duct and there was an extensive biliary cirrhosis The man died two or three days after this operation, and at autopsy over 650 stones were found extending out as far as the extreme limits of the ducts, some fairly large, and with the stones there was a considerable amount of the same detritus material

CARCINOMA OF STOMACH NINE YEARS AFTER OPERATION

DR WINFIELD SCOTT SCHLEY presented a man, fifty-six years of age, who was admitted to hospital June 1, 1917, and discharged June 29, 1917 Operation, resection of pyloric one-third of stomach, posterior gastro-

enterostomy, suture of trans-mesocolon to posterior wall of stomach. The patient had complained of sixteen years' duration of epigastric distress and gas with constipation. Catharsis always relieved his symptoms. Distress for six months before entrance worse, but there had been no vomiting. Had not noticed blood in the stools. X-ray examination showed filling defect at pyloric third and shadow residue three inches in diameter after six hours. Glands in the lesser omentum and along the greater curvature considerably enlarged (up to 1 cm diameter), but were not involved microscopically. Patient made a good convalescence and has remained well nine and a half years.

CICATRICAL CONTRACTION FOLLOWING BURNS

DR WINFIELD SCOTT SCHLEY presented a little girl, eight years of age, who, several years before her entrance into the hospital on February 4, 1926, was badly burned (to the third degree) on neck, chest, shoulder and right arm. This had resulted in severe contractures of the neck and arm. The chin could not be elevated and the arm could not be abducted over 20 degrees from the side. In the neck the worst of the scar tissue was outlined and dissected from the deeper layers. It was found that even the muscles were involved and the superficial layers replaced by scar tissue. The skin and subcutaneous tissue upon the sides of the neck were dissected up and freed almost to the trapezius edge. Upon the left side an incision was made just above the clavicle, allowing the left flap to be drawn up to the maxilla. After this free dissection the left and right flaps could be approximated by sliding in the midline and held by fine silk. The skin in so young a child being quite elastic, it was even possible to extend right and left flaps across the midline to make up for deficiencies on either side. A quick primary union resulted with restoration of neck function. The area above the clavicle upon the left side was not drawn together but later skin grafted.

The arm was freed from the side by an incision directed towards the apex of the axilla and carried up to the edge of the major pectoral muscle, and superficially a little above both in front and behind this level. The arm could now be freely abducted and extended. It was possible, due to the high skin mobility, to slide a flap from the side of the chest to cover this whole defect of the axilla. Careful attention was paid to the dressing at the time of operation, and firm yet elastic pressure with comparative immobility of the arm was maintained for the first week. Primary union again resulted and complete arm motion and function were restored.

For further cosmetic effect future procedures may be planned, the ones described having been solely to restore function, but an enormous gain in appearance has resulted as well.

DR HUGH AUCHINCLOSS considered that the main feature in correcting these contractions in the neck was in the avoiding of a longitudinal scar. Many of the cases that come for relief have been operated on frequently beforehand, and longitudinal scars have resulted in most of them.

DOCTOR SCHLEY added that he had had this point in mind and had attempted to avoid a midline contracture by staggering the flaps. The result, as could be seen, was most satisfactory and presented no evidence of contractural effect.

OBSERVATIONS ON CARCINOMA OF THE STOMACH

SKIN GRAFT FOR WEB FINGERS

DOCTOR SCHLEY presented a little girl, three years of age, on whom he had operated for completely webbed fingers resulting from extensive burn of the left hand. On admission to the hospital the fingers were found to be all fused to the terminal phalanges. The result, a year and a half after operation, shows complete separation of fingers to heads of metacarpals with perfect functional and cosmetic result. This was accomplished by deeply dividing the webbing down to and between the heads of the metacarpals and Thiersch skin grafting, the graft being carried well down to the bottom of the incision and kept there by a narrow bandage pulled well down between each finger. The incision and graft were carried well down to avoid the tendency to heal back and obliterate the deeper part of the cleft. The graft, cut nearly to the length of two fingers, was then carried along the cut surface, exposed on both sides, covered with gutta serena tissue and the fingers and hand carefully bandaged and immobilized on splint. There was a 100 per cent take in the grafts.

OBSERVATIONS ON CARCINOMA OF THE STOMACH BASED ON A FOLLOW-UP STUDY OF SURGICAL TREATMENT

DR FORDYCE B ST JOHN read a paper with the above title and presented five of the patients whose cases were reported in the paper.

DR ALLEN O WHIPPLE considered that it was not generally realized what a remarkable amount of work and careful study was required in order to carry out such an analysis as that presented by Dr St John, not to speak of the many hours spent in the follow-up clinic. The actual results, however, are to be determined only by actually seeing the patients. One can be very easily deceived if one depends on the patients' statements alone.

There were two things Doctor Whipple wished to emphasize and the first was the importance of early diagnosis. From a study of these cases one was struck by the importance of a history of loss of weight, loss of strength, diminished appetite and asthenia, and these symptoms should be regarded with the greatest concern. That particularly holds true in the medical clinics, where these patients are usually seen first. Much valuable time had been lost in the cases in this series. The next important point is the fact that one cannot determine the operability by what appears to be lymph-node involvement or the size or the character of the mass felt in the stomach itself. Of the five cases shown here this evening there was doubt in three that the case was a fit one for radical resection. In the one that was living the longest time after resection, Doctor Lambert, who operated, had doubted the wisdom of removing a growth of that size. From the fact that only one of these cases had lymph-node involvement, it appears that enlargement of the nodes should not be a deciding factor in resection. The finding of a mass at the time of operation or before is not an indication of the possibility of resection in cases of this sort. The fact that in such a large percentage of the cases of the entire series liver involvement was present may explain why so many of these cases die rapidly when no local extension is discovered at the time of operation.

DR NATHAN W GREEN remarked further on the importance of early diagnosis In making that diagnosis, other things being equal, weakness and loss of weight were the two most important symptoms The diagnosis then might be checked up by X-ray The second point was, it was very desirable to instruct or encourage the general practitioner in the understanding that carcinoma of the stomach was not necessarily a hopeless condition That opinion seemed to prevail throughout the profession both in the city and in outlying districts If that could be overcome patients would come to the hospital in a more favorable frame of mind and if there were a chance promised them by the surgeon they would be more likely to accept it

DR JOHN DOUGLAS said that Doctor St John's statement that the average duration of the symptoms was eight months, the longest three years, and the shortest a few days, was of interest as an indication that probably none of these cases were a conversion of a gastric ulcer into carcinoma of the stomach. Another point that no one had called attention to was the fact that in the follow-up of these cases, the average case occurred in the fifth decade of life and frequently in the sixth If one follows these cases after that, life insurance statistics will show that death is apt to occur, in the ordinary course of events, from other diseases earlier than in a younger age group

DR. HUGH AUCHINCLOSS, referring to Doctor St John's statement that all the cases were checked by biopsy, said that this was very important Many times at an exploratory laparotomy a large mass may be found in the stomach, assumed to be carcinoma, and no specimen removed for examination This patient may or may not live for a long time afterward with the diagnosis always a questionable one An effort should be made to at least remove a neighboring lymph-gland in all cases where the procedure wont harm the patient

DR HERMANN FISCHER said that every time he heard such statistics as those of Doctor St John he felt encouraged in continuing to attempt the operative cure of these cases The size of the lesion should not militate against operation, he had noted many times that where cases looked almost hopeless operation proved to be very satisfactory and the metastatic condition in the lymph-nodes was very small On the contrary, many very small growths had proven to be highly malignant He believed that every case of carcinoma of the stomach should have the benefit of exploration

DOCTOR ST JOHN, in closing, said one is impressed with the relative prognosis in these cases One will see an apparently rapidly growing carcinoma operated on and the patient will be found alive eight years later Another patient with a growth which seems small will be dead soon after operation There had been a tendency to get away from the retrocolic type of operation in this series, except the Billroth II, and in all cases, except one, where a long loop ante-colic anastomosis was used, it was accompanied by an entero-enterostomy

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held December 6, 1926

The President, DR CHARLES F. MITCHELL, in the Chair

ETHYL CHLORIDE IN LOCAL ANÆSTHESIA

DR JOHN B CARNETT demonstrated a method of securing satisfactory local anæsthesia with ethyl chloride. The skin and subcutaneous fat overlying a superficial abscess can be completely anæsthetized by spraying with ethyl chloride but the inflamed hypersensitive tissues beneath the abscess are not influenced by this anæsthetic. The usual practices of making an incision either by a simple heavy stroke of the knife or by transfixion and cutting from within outward, transmit pressure or pull through the abscess to the adjacent non-anæsthetized tissues causing great pain. By using a thin-bladed sharp knife and making pressure, too gentle to be transmitted to the depths, all pain is avoided. This may require two to six gentle knife strokes to cut through the perfectly anæsthetized tissues overlying the abscess.

The most satisfactory container for ethyl chloride is the one having a screw valve to regulate the size of the stream. The nozzle of such a container can be held within two or three inches of the abscess and by adjusting it to a very fine spray, anæsthesia results very promptly. The stream from a valveless container is so coarse that even when sprayed from a distance of 16 to 18 inches the ethyl chloride does not evaporate properly, hence anæsthesia is delayed, solution is wasted, unevaporated solution tends to flow into undesired situations as into the eye, and the area to be anæsthetized cannot be so accurately circumscribed. Manufacturers of valveless sprays should be condemned for their practice of sending printed instructions to blow on the surface to expedite evaporation of the solution. Blowing tends to contaminate the surface and succeeding wound with a variety of pathogenic germs from the surgeon's mouth.

Four or five years ago he adopted ethyl chloride as the preferred local anæsthetic for taking biopsies from ulcers suspected of being cancerous, the danger of embolism of cancer cells is increased by the injection of anæsthetic solution but is minimized by freezing which tends to hold the cells *in situ* during the incision.

CHRONIC STRAIN OF THE LUMBAR SPINE AND SACRO-ILIAC JOINTS

DR JOHN B CARNETT read a paper with the above title.

DR DAMON B PFEIFFER remarked that Doctor Carnett's theory is a very ingenious and possibly satisfactory explanation for certain cases of the ten-

derness which is frequently elicited in the right and left iliac fossæ. Some years ago Robert Morris maintained that tenderness in this same location was an important sign of chronic appendicitis, his explanation being that chronic disease of the appendix gave rise to a state of irritation and tenderness over the lumbar ganglia.

At the last meeting of the American College of Surgeons in Philadelphia, the speaker had occasion to participate in a consultation with Sir Arbuthnot Lane in a case of carcinoma of the transverse colon. The condition was sufficiently obvious, but he was especially interested in Sir Arbuthnot's method of abdominal examination. He laid great stress on tenderness in the same locations pointed out by Doctor Carnett. His interpretation of the matter was that carcinoma was a sequence of intestinal stasis and this in turn by causing strain on supporting intestinal ligaments, gave rise to the obvious tenderness in the right and left iliac fossæ.

In the presence of such differences of opinions the matter cannot be regarded as settled. There is no question that many appendices are being removed largely on the evidence of tenderness in the right iliac fossa, and it is well to realize that there are other pitfalls in the diagnosis than the well-known sources of error such as renal and ureteral disease, pelvic disease, lymphatic glandular inflammation and other rarer conditions.

RESULTS IN GALL-BLADDER SURGERY

DRS E. L. ELIASON and L. K. FERGUSON read a paper with the above title.

DR GEORGE P. MULLER remarked that in this subject the primary mortality is of first importance and he was pleased to note that Eliason and Ferguson had grouped their cases according to pathology and not according to operation, cholecystectomy or cholecystostomy as is so often done. It makes little difference which operation is done in chronic gall-bladder disease, with or without stones. The mortality is negligible and dependent upon other factors than the type of operation. In acute empyema of the gall-bladder the case is different and here the mortality from cholecystectomy is higher than cholecystostomy. There is need for discrimination even if a secondary operation is necessary later.

In the common duct group he was somewhat at a loss to find the reason for his high mortality. He delays operation and practices careful pre-operative care. Perhaps it would be better to tap the gall-bladder if it will drain or the common duct if that is necessary and leave the removal of the stone, as suggested by Crile, to a later time. It certainly is a mistake radically to "spoon" the ducts in a sick patient. These patients often have a pancreatitis and extensive liver involvement and correct post-operative treatment is essential. Blood transfusion and glucose intravenously are routine on his service.

End result studies are not always easy. In his own hospital the follow-up is highly efficient but the patients are not followed for a sufficient length of

POST-OPERATIVE WATER METABOLISM

time In a paper from the Mayo Clinic published last summer, it was noted that cases considered as cures came back many years later with recurrence of the gall-stones In the series which he reported last year 85 per cent of the chronic gall-bladder group with stones and 70 per cent of the simple cholecystitis claimed perfect health The difference probably represents the margin of failure to cure the complete pathology He had been working on this last group lately. It seemed to make no difference whether or not the appendix was removed concurrently, nor was age a factor The end results are apparently a matter of correct diagnosis, precise operating, and the avoidance of drainage whenever possible. However, he had 90 per cent of perfect results in the empyema group and 76 per cent of cures in the common duct cases, both of which were extensively drained

In regard to anæsthesia, he now uses local anæsthesia and ethylene Impressed by the use of posterior splanchnic anæsthesia in the hands of Eliason and Ferguson, he tried it in a few cases, but the marked fall of blood-pressure was very alarming, even though all of his cases recovered

DOCTOR ELIASON remarked that the alarming fall in blood-pressure which accompanied splanchnic anæsthesia had been obviated by reducing the amount of adrenalin used He now uses only half the amount which he formerly employed

INTRADERMAL TEST FOR THE DETERMINATION OF POST-OPERATIVE WATER METABOLISM

DRS KENNETH E APPEL and SELLING BRILL read a paper with the above title.

DR GEORGE P MULLER said that this test seems at first a trifling one, the producing of a wheal and the watching of the wheal disappear But it has given rise to the most interesting amount of speculation about acidosis and water metabolism He thought when they first started this work that local acidosis would explain the phenomenon In one case of diabetic gangrene they were interested to know whether to amputate below or above the knee The disappearance time was 40 above the ankle, 50 in the calf, and 60 at the knee, according to this test he could safely amputate below the knee. This was done even though he knew how dangerous it is in the average case The stump has done well.

According to the later theory, however, the test seems to relate to an entirely different thing and has nothing to do with acidosis. As a means of determining whether or not the patient is in need of water, the test may hold promising possibilities

DOCTOR BRILL said that they were not at all certain of the value of this test in interpreting post-operative water metabolism; the mechanism and the disappearance of the wheal is not at all understood Originally, workers with this intradermal wheal attempted to explain it on the basis of the work of Martin Fischer, who pointed out that colloids imbibed water when their acidity was increased Fischer further believed that there was a local

acidosis of the tissues, and this caused an imbibition of water. On this basis he attempted to explain all types of œdema. That there may be a local acidosis has been recently confirmed by the work of Rous at the Rockefeller Foundation.

However, especially since the publication of Loeb on "Proteins and the Theory of Colloidal Behavior" in 1922, this theory of Fischer's has been discredited because Loeb showed that this imbibition of water with increased acidity took place at a pH below the isoelectric point, and that there was also a swelling of the colloid with increased alkalinity on the alkaline side of the isoelectric point. The isoelectric point of most of the body proteins is in the neighborhood of a pH of 4.7 to 5. Physiological processes in the body take place at a pH of 7 to 7.4. Therefore increased acidity would be expected to cause a decrease rather than an increase in the absorption of water by the body colloids at this pH. As a matter of fact there is no doubt that a shift of water between cells, lymph, and serum takes place with a change in pH. However, in which direction this shift takes place it is premature to attempt to state at this time.

The disappearance of the wheal post-operatively might perhaps be explained by considering the relation between the capillary pressure and the osmotic pressure of the blood. Post-operatively, there is perhaps a dehydration which causes an increase in the osmotic pressure of the blood and therefore a more rapid disappearance of the wheal. This is in line with the explanation given for œdema by Starling in his book on *Human Physiology*. They are now at work on this problem.

NOTE—Since the presentation of this paper, further work, under direction of Dr. J. H. Austin, has shown that the above explanation is probably incorrect.

USE OF THE RUSSELL APPARATUS IN THE TREATMENT OF FRACTURE OF THE SHAFT OF THE FEMUR

DR. THOMAS J. RYAN read a paper with the above title.

DR. DAMON B. PFLIFFER said that this method is a valuable addition to the treatment of fractures. It employs the principle of balanced traction in a most ingenious manner and if general experience bears out the satisfactory character of the results as reported here, it should be widely adopted. Apropos of the fact that quite a number of the cases reported in this paper were children, he would mention two features which are valuable to remember.

The first is, that it is comparatively easy to "set" a transverse fracture of the femur in children. Of course it is useless to attempt to replace spiral or oblique fractures by manipulation, but in the case of transverse fractures, by a combination of traction and manipulation, it is nearly always possible to lock the fragments as to make the after-treatment a very simple matter. The most effective manoeuvre in bringing about this end-to-end apposition is to angulate the bones sharply with traction on the distal fragment and then, holding the bones in alignment in the plane of angulation to bring them

FRACTURE OF THE SHAFT OF THE FEMUR

slowly up to their normal position. Even when the fracture has existed for some days and overriding is extreme so that direct traction will not succeed in reducing the shortening, it is usually possible to lock the fragments in this manner. Recurrence of deformity may be prevented readily by coaptation splints and fixing the leg in suspension with just enough traction to effect immobilization. He was not referring, of course, to supracondylar fractures or those of the upper end of the femur, but only to those which occupy a position somewhere within the middle two-fourths of a long bone.

The second important consideration in the treatment of fractures in children is the fact well-known to those who have had experience in the treatment of acute fractures during the early years of life, that growing bones have a truly marvelous ability to correct malpositions and even shortening due to lack of correct anatomical reposition after fracture. Ashhurst has called attention to the way in which function and muscle balance shape the skeleton in childhood. Truesdell, Speed, and others have shown vividly that misalignment and shortening may be almost disregarded in early childhood. A fractured long bone is stimulated to increased growth by the fracture, and if shortening is present it soon overtakes its fellow on the opposite side. Angulations and overriding are so compensated that it is often difficult after the lapse of a year or two to discover either by examination or by the X-ray where the site of fracture has been. He ventured to speak of this at some length because these factors are not generally appreciated. About two years ago in taking over a surgical service from one of his colleagues in a hospital in this city, he found in the children's surgical ward a small boy about five years old who had had a fracture of the middle of the femur. He had been treated by the overhead suspension method of Bryant. The alignment was good and the shortening not more than a half inch. Callus had already formed and the fracture was fairly stable. Relying on the facts just stated he felt that the end result would be not only good, but perfect, and in due time arranged to send the child home. Unfortunately in this case one of the members of the family happened to be a nurse from another city and she asked to see the X-ray and was horrified to find the position of the fragments as he had just described them. He explained to her the prospects, but it developed that with a true layman's horror of X-ray deformities she took the child to see a well-known surgeon in this city, whose work is not with acute fractures but with chronic bone conditions, and to the speaker's great surprise he sent the child back to the hospital, broke up the union, and put on a plate. A better appreciation of the behavior of fractures in children would be a safeguard against the perpetration of bad surgery of this sort.

DR J. TORRANCE RUGH remarked that every one of these cases presents its own problems. The results shown by Doctor Ryan are certainly good and yet when one tries extension in other cases and after a most thorough application of the extension for a period of ten days or perhaps two weeks, one fails to get apposition and fails to overcome the overlapping—then one wonders how it is that the extension always succeeds in the cases reported.

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It is his practice to operate, if after ten days, apposition of the fragments cannot be secured.

DR. A. P. C. ASHHURST said that it is a pleasure to see surgeons take an interest in fractures of the femur, even if it requires a new and complicated apparatus to interest them. In all probability, the same results can be obtained by simpler means, but if it takes a complicated apparatus and a newer method to interest them, let us have it. Doctor Ashhurst agrees with Doctor Pfeiffer in that he never saw a fracture of the shaft of the femur in a child which did not give a good result, no matter what the treatment. To operate for malunion, in a case such as he has described, would seem to border on malpractice.

DR. GEORGE P. MULLER said that this method of treating fractures of the femur is not new in principle but has brought out several interesting points. The results obtained are probably no better than those which Doctor Ashhurst reported to the American Surgical Association as having been secured by Buck's extension, but the dressing is exceedingly uncomfortable for the patient and the results speak for themselves. It is true that they plated several of the cases, but then the method is not infallible and there will be occasional failures. In addition to the fractures of the shaft reported, they had several cases of fracture of the neck of the femur with good results and there was one pathologic fracture of the femur secondary to carcinoma of the prostate which healed in perfect position. They had one case of peroneal palsy in which a simple sling was used under the knee and with the leg on a pillow. This apparatus is more comfortable than a plaster case and patients seem to like it better than the Buck's extension.

Replying to Doctor Rugh's remark, Doctor Muller said that he operated on three of the twenty patients; one without reason, and one maybe without reason, and the other because he could not get reduction. Patients require attention with the Russell apparatus. If shortening recurs when the weight is removed, it means interposition of the tissue between the fragments. In the cases reported he secured perfect apposition.

CHANGE OF EDITORIAL ADDRESS

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THE TREATMENT OF ACID AND ALKALI BURNS

AN EXPERIMENTAL STUDY

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ALTHOUGH acid and alkali burns of the skin are of frequent occurrence, the treatment of such lesions has not received the critical attention which it merits. A few special types of chemical burns of the eyes have been investigated, but in this situation the caustic is acting under quite different conditions than upon skin. Unlike the eye, skin is protected by a resistant horny layer of cells whose vulnerability is further lessened by its normal oily secretion. A chemical burn may occur only after this protective mechanism has been penetrated either by a strong caustic or by prolonged contact with a less concentrated one.

Acids and alkalis produce changes in the tissues which are similar to those caused by heat, but the problem of management is an entirely different one. Heat burns are more or less self-limited in depth because tissue is a poor conductor of heat and any hot material which may splash on skin soon chills. Such a lesion is then in condition to proceed with the

normal reparative processes. In acid and alkali burns the destructive action of the caustic may be progressive because any considerable excess of either H or OH ions is incompatible with cell life.¹ The problem of management of such lesions is then primarily one of disposing of the irritant which is still present so that the process of healing may begin.

The principle of neutralization has been the basis of treatment of such burns. Acetic acid has generally been the agent used in alkali burns and sodium bicarbonate in acid burns. Smith² and Holland,³ however, have advocated the use of water as a first-aid treatment and secondary neutralization. This difference of opinion from generally accepted practice was not supported by any observations of burns treated by the two methods under controlled conditions. Because of the fundamental importance of the disposition of the acid or alkali, it seemed desirable to determine the efficacy

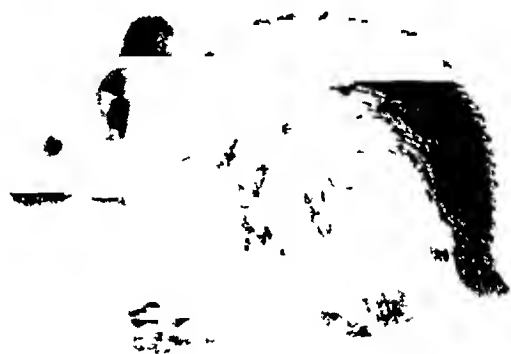


FIG. 1.—Showing rat 24 hours after exposure for 15 seconds to 70-71 per cent nitric acid which was treated by washing with water. The control animals and the rats treated by neutralization succumbed in less than 14 hours.

of neutralization in contradistinction to simple dilution in experimentally produced burns of this origin

Classification—The degrees of cutaneous irritation seen in acid and alkali burns are identical to the changes produced by heat burns of increasing severity. A first degree burn is shown by an arterial and capillary hyperæmia. The dilatation at first involves the superficial vessels, but later progressively

involves the deeper subcutaneous tissue partly directly and partly by reflexes. This congestion is accompanied by itching, burning and pain. When the irritant sets up such a vigorous inflammatory reaction that exudate is formed more rapidly than it can be carried away by the lymphatics, vesicles or blebs form, which characterize a second degree burn. Sollman⁴ states that this accumulation of fluid takes place between the upper and lower layers of the rete Malpighii. The remaining layers of



FIG. 2—Showing rat 24 hours after exposure for 15 seconds to 96 per cent sulphuric acid which was treated by neutralization with sodium bicarbonate (Compare with Fig. 3)

the rete Malpighii have but little resistance to infection and in this way there may be actual loss of tissue substance. If the corrosive agent continues its action beyond this stage actual cauterization of the tissue or a third degree burn results. This type of lesion is caused by strong acids and alkalis. Such burns show three fairly well-defined areas, first, there is inflammation and hyperæmia at the depth and periphery of the lesion, next a layer of necrotic tissue, and finally a layer in which solution of the individual cells has taken place.

Method—Rats were used in all experiments which were done in triplicate. The animals were anaesthetized with ether and a hind leg was immersed for a given period in the test solution, which was at room temperature. Three groups of animals were kept under observation for each concentration of acid or alkali tested. In one group the excess of the caustic was carefully wiped away with cotton and these were considered the controls. The irritant was neutralized in the rats of the second group with five per cent sodium bicarbonate for the acid burns and one per cent acetic acid for the alkali burns. The rats in the third group were treated by vigorous washing with water. This was accomplished either by holding the affected part under a running tap or by



FIG. 3—Showing rat 24 hours after exposure for 15 seconds to 96 per cent sulphuric acid which was treated by vigorous washing with water (Compare with Fig. 2)

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placing the animal in a large tank of water. The animals were then placed in separate cages and nothing further was done to alter the course of the tissue reaction to the caustic. If death did not occur promptly in those rats which showed extensive sloughing the animal was sacrificed.

The latent period of sensory stimulation of various concentrations of the same acids and alkalis were determined in three individuals by applying a drop of the caustic upon the inner surface of the forearm. All observations were done in duplicate and the reaction time was measured with a stop watch.

Acid Burns—The action of concentrated acids⁴ consists of withdrawal of water in the formation of acid albumins, in softening of the connective tissues and epithelium and in special situations in solution of calcareous material. The acid albumins are insoluble in moderately strong, but soluble in concentrated

or weak acids. The affinity for water is so strong in the case of concentrated sulphuric acid that not only is water withdrawn from the tissues, but the elements hydrogen and oxygen are split off from their chemical combination with carbon leading to charring.



FIG. 4.—Showing rat 24 hours after a six minute contact with 37 per cent hydrochloric acid. Control animal in which the excess was carefully wiped away. (Compare with Figs. 5 and 6.)

RESULTS

Mineral Acids, Nitric Acid—When nitric acid comes in contact with skin or hair it gives the characteristic yellow xanthoproteic reaction. The caustic action of a thirty second exposure to 70 or 71 per cent nitric acid was observed in three rats. Death occurred promptly and autopsy revealed involvement of skin, subcutaneous tissue and muscle to such a degree that it appeared impossible to arrive at a conclusion about what might be accomplished by treatment.



FIG. 5.—Showing rat 24 hours after a six minute contact with 37 per cent hydrochloric acid which was treated by neutralization with sodium bicarbonate. (Compare with Figs. 4 and 6.)

Three groups of rats were then exposed to acid of this same concentration for a fifteen second interval. There was practically no latent period before activity began. This was evidenced by xanthoproteic reaction of the hair and skin, prompt edema and complete disability of the extremity. Death occurred in the control animals in three to six hours and autopsy revealed that the depth of the burn extended down to and involved the underlying muscle.

The second group of rats which were treated by prompt neutralization with sodium bicarbonate differed but little from the control animals. The leg became edematous promptly, and was held rigid in extension. The hair separated readily from the skin. Such animals succumbed in five to fourteen hours and again autopsy revealed involvement of the underlying muscle in the burn.

The animals in the third group which were vigorously washed in water, showed the characteristic xanthoproteic reaction of the hair and skin, but the hair did not pull out readily (See Fig 1) There was marked oedema of the extremity at the end of twenty-four hours, but unlike the previous animals, the treated extremity was useful All of these rats survived and although some late sloughing occurred, healing took place without any disability

A series of experiments were performed using 50 per cent nitric acid for intervals varying from fifteen to sixty seconds A group of six rats were used to test the effect of the acid for each time interval, in three rats the acid was neutralized and in the others



FIG 6—Showing rat 24 hours after a six minute contact with 37 per cent hydrochloric acid which was treated by washing with water (Compare with Figs 4 and 5)

thorough washing was employed The rats which were exposed to the acid for fifteen and thirty seconds whether treated by neutralization or water, did not reveal a true burn, but there was the usual xanthoproteic reaction The ones which were immersed for forty-five seconds showed oedema of the extremity and this was equally marked in both groups The rats which were immersed for sixty seconds and neutralized acted entirely differently, however, from those which were washed In the former the extremity was curled up, shrunken, dark colored and useless, and death occurred in about eighteen hours In

the latter the only evidence of contact with the caustic was oedema of the foot and characteristic coloration of the hair None of the animals revealed any evidence of disability and all recovered

Sulphuric Acid—Similar experiments were performed with 96 per cent sulphuric acid The period of immersion was fifteen seconds The action upon the skin was so



FIG 7—Showing rat 18 hours after a six minute contact with 50 per cent sodium hydroxide Control animal in which the excess was carefully sponged away with cotton Gangrene of hind leg is evident (Compare with Figs 8 and 9)

Death generally occurred in animals so treated in ten hours and invariably in less than twenty-four hours A third group were treated by neutralization with 5 per cent sodium bicarbonate and again similar sensory stimulation was seen during the process, but not as great heat evolution was observed Oedema and redness developed promptly and there was complete disability of the extremity which was drawn up under the animal (See Fig 2) Eighteen hours later extensive sloughing of the skin over the thigh began and death occurred in twenty-four to forty-eight hours A fourth group was treated by vigorous washing with water The sensory stimulation which was seen during

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the process of neutralization was not observed. There was prompt redness and œdema of the extremity, but this subsided in about twenty-four hours. The leg remained useful and at no time was there any disability caused by the irritant. (See Fig 3) In no instance did any late sloughing occur and all animals recovered.

Observations were then made using 50 per cent sulphuric acid for an interval of thirty seconds. In the control animals a burn occurred which extended down to muscle and the skin of the thigh formed one large slough. No charring occurred. These animals succumbed in about eight hours. Neither the rats which were treated by washing nor those treated by neutralization showed any evidence of a burn.

The effect of immersion for one minute in a 25 per cent solution was next determined. The controls which were sponged revealed only a slight redness of the extremity but no actual burn. The treated animals revealed no signs of the effect of the irritant. Immersion for one and one-half minutes in a 10 per cent solution did not produce any lesion even in the control animals.

Hydrochloric Acid—The caustic action of hydrochloric acid was much less vigorous than that of the acids just described. It was necessary to immerse the extremity in 37 per cent acid for one minute and allow further contact for five minutes before proceeding with treatment to produce analogous lesions to those previously described. The control animals showed a gradually developing œdema and the leg slowly went into a position of contracture. (See Fig 4) The toes became gangrenous and after eighteen hours sloughing of the skin of the thigh developed. Death occurred in about twenty-four hours. The rats which were treated by neutralization showed sloughing of the skin of the thigh



FIG 8—Showing rat 24 hours after a six minute contact with 50 per cent sodium hydroxide which was treated by neutralization with acetic acid. (Compare with Figs 7 and 8)



FIG 9—Showing rat 24 hours after a six minute contact with 50 per cent sodium hydroxide which was treated by washing vigorously with water. (Compare with Figs 7 and 8)

at the end of twenty-four hours the leg was useless and death generally occurred in about thirty-six hours. (See Fig 5) The animals which were treated by vigorous washing showed some œdema of the extremity and redness of the feet. (See Fig 6) At the end of forty-eight hours the hair began to separate, but no sloughing of the skin occurred and all rats so treated survived. An effort was made to produce burns with less concentrated acid, but this was ineffectual because of difficulty experienced with the anæsthetic and protecting the lungs from the fuming acid.

Organic Acids, Acetic Acid—It was deemed advisable to determine whether

organic acids acted similarly to the mineral acids. The animals were immersed in 99 per cent acetic acid for thirty seconds. In the control animals the extremity invariably turned an intense red color, but the hair did not show any alteration. All of the rats succumbed in less than two hours and examination revealed that the skin which appeared intact upon inspection was completely destroyed and readily separated from the muscle. Little difference was noted between the animals which were treated by neutralization from those

which were washed. In each instance there was œdema and redness but no actual sloughing of the skin. Exposure to the same concentration for one minute merely increased the severity of the local reaction but no real difference was noted between the rats treated by the two methods. When rats were immersed for one minute and an interval of five minutes was allowed before proceeding with treatment all died regardless of what was done. However, when the interval was lessened to two minutes before proceeding with the treatment, all of the animals from which the acid was removed by washing survived, while two out of three which were treated by neutralization succumbed in less than eighteen hours.



FIG 10—Showing rat 18 hours after a six minute contact with 50 per cent potassium hydroxide. Control animal in which the excess was carefully sponged away with cotton. Gangrene of hind leg present (Compare with Figs 11 and 12)

Trichloroacetic Acid—The caustic action of a saturated solution of trichloroacetic acid was observed in three groups of rats. The period of immersion was one minute. The exposed extremity in the control animals immediately became rigid and was held in extension. The skin became milky white within a few minutes, the hair showed no change. Death occurred in such animals in about one and one-half hours. The animals which were treated by neutralization and by washing showed essentially the same picture. The extremity was useless, it was held rigidly in extension and the skin was white in color. The entire leg in all these rats

appeared devitalized. Death occurred in the treated animals in ten to twelve hours. Experiments were then done using a half saturated solution and exposing the animals for thirty seconds. The control animals again showed complete disability of the exposed extremity. The rats appeared quite toxic within half an hour after contact with the acid and succumbed in four to five hours. The rats whose lesions were treated by neutralization showed the same characteristic white skin. The leg was pulled up under the body but was used occasionally. At the end of eighteen hours there was moderate œdema and the rats died in twenty-four to thirty-six hours, but at autopsy there was little gross evidence of a burn. The rats which were treated by washing showed œdema of the foot at the end of eighteen hours, but no disability resulted from the lesion and the general activity of the animals did not appear decreased. One rat died fifty hours after exposure to the acid. Another showed the late development of a slough on the lower leg, but the toes remained intact and revealed no deformity.



FIG 11—Showing rat 24 hours after a six minute contact with 50 per cent potassium hydroxide which was treated by neutralization with acetic acid (Compare with Figs 10 and 12)

Alkali Burns—According to Holland³ the effect of alkalis is local and limited to the part with which they come in contact. Ammonia, however, may be an exception in view of the three lethal cases reported by Fairbrother, in which death occurred from respiratory and cardiac failure within five hours of the accident. The corrosive action of alkalis are thought to be due to the free alkali combining with the tissue elements forming alkaline albuminates

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or with fats to form soaps. Their hygroscopic action of withdrawing water from the cells also contributes to the necrosis. The sloughs which they form are very soluble and consequently alkali penetrates deeply into tissues. It is stated that the total effect upon tissue depends upon the total quantity of OH ions which can be split off under the conditions of the body. The "actual or immediate effective alkalinity of a solution depends upon the dissociated OH ions, but as these combine with the tissues, further OH ions are split off (potential) alkalinity which continue the action."⁴

RESULTS

Sodium Hydroxide—A long latent period for 50 per cent sodium hydroxide was observed. It was necessary to immerse the extremity for one minute and allow the contact with the caustic to continue for five additional minutes before proceeding with treatment, in order to obtain a satisfactory lesion. The skin and hair of the control animals varied but little from normal appearance at the end of this six minute interval. Gradually oedema and maceration of the skin with the formation of thick oedematous sloughs developed. (See Fig 7) The maceration of the tissue was entirely unlike the destruction seen in acid burns and appeared characteristic of alkali burns. The action of the sodium hydroxide after once begun was rapidly progressive and all of the control animals were sacrificed in eighteen hours. The rats whose lesions were treated by neutralization showed oedema and redness of the foot at the end of twenty-four hours and gradually the skin of the thigh and flank sloughed, however, recovery occurred. (See Fig 8) The hair of the rats which were treated by washing remained intact. No sloughing of the skin occurred. (See Fig 9) The only evidence of a burn was moderate oedema of the toes and excoriation of the skin of the foot, however, healing took place promptly and without deformity.



FIG. 12—Showing rat 24 hours after a six minute contact with 50 per cent potassium hydroxide which was treated by vigorous washing with water. (Compare with Figs 10 and 11.)

Potassium Hydroxide—Here again on account of the long latent period, the same duration of exposure to 50 per cent potassium hydroxide was necessary as in the experiments with sodium hydroxide. A progressive lesion was again noted in the control animals. (See Fig 10) At the end of eighteen hours the foot was swollen and purple in color. The skin was exceedingly moist and macerated. The toes were shrivelled and gangrenous. The skin was broken in numerous places exposing the muscles of the thigh. The controls were sacrificed at this time. The lesions of the rats treated by neutralization were quite similar. (See Fig 11) The extremity was useful but there was great disability. The skin was oedematous and red, and over the thigh sloughing occurred. The toes were dark colored and presented the picture of a dry gangrene. The rats treated by washing, unlike the control and neutralized rats, showed only slight redness of the foot. (See Fig 12) There was no oedema and the extremity functioned normally. The hair was everywhere intact and it was difficult to actually demonstrate a burn.

Lime—An effort was made to produce experimental burns with lime but there are other factors involved than its purely alkaline nature. Calcium oxide may be placed on dry skin and no reaction takes place, the skin likewise tolerates calcium hydroxide, which is not a very active alkali. During the process of slaking, the factor of heat is of tremendous importance. The heat of solution of a single gram of calcium oxide is 18,330

calories To test the duration of this thermal factor water was added to about 5 grams of calcium oxide The temperature immediately rose to 98° centigrade When activity of calcium oxide has once begun on skin there is an addition to this heat factor the avidity of the lime for water which causes further tissue necrosis Because of this complicated action lime does not lend itself readily for investigation of tissue changes caused by alkalinity

Sensory Threshold of Skin—In view of the tremendous difference in the time factor observed in acids and alkalis before tissue injury occurred, it

TABLE I

Showing Latent Period of Sensory Stimulation of Various Caustics

Caustic	C W M Latent period	E C D Latent period	W C E Latent period
Acetic Acid 99 per cent 50 per cent 25 per cent	14" 3' No stimulation 3' No stimulation	11 8" 3' No stimulation 3' No stimulation	17" 3' No stimulation 3' No stimulation
Trichloroacetic Acid Saturated Solution Half Saturated Sol	5" 17"	14" 15"	13" 16"
Potassium Hydroxide 50 per cent 25 per cent	3' No stimulation 3' No stimulation	3' No stimulation 3' No stimulation	3' No stimulation 3' No stimulation
Sodium Hydroxide 50 per cent 25 per cent	3' No stimulation 3' No stimulation	3' No stimulation 3' No stimulation	3' No stimulation 3' No stimulation
Ammonium Hydroxide 28 per cent	3' No stimulation	3' No stimulation	3' No stimulation
Nitric Acid 70 per cent 50 per cent 25 per cent 10 per cent	4" 37" 3' No stimulation 3' No stimulation	2" 22 6" 3' No stimulation 3' No stimulation	8" 45" 3' No stimulation 3' No stimulation
Sulphuric Acid 96 per cent 50 per cent 25 per cent 10 per cent	3 5" 50" 3' No stimulation 3' No stimulation	4 6" 45" 3' No stimulation 3' No stimulation	4" 48" 3' No stimulation 3' No stimulation
Hydrochloric Acid 37 per cent 25 per cent	15" 3' No stimulation	17" 3' No stimulation	

seemed desirable to determine the latent period upon human skin before a sensory response took place These observations are summarized in Table I It is interesting to note that in the highly concentrated mineral and organic acids stimulation occurred in 3.5 to 8 seconds and relatively slight changes in the concentration cause a marked prolongation of the latent period When a 25 per cent concentration was reached none of the acids gave a sensory response in three minutes It is of further interest to note that 50 per cent

THE TREATMENT OF ACID AND ALKALI BURNS

sodium and potassium hydroxide and 28 per cent ammonium hydroxide gave no stimulation in three minutes

Discussion—The results of the experiments with acids and alkalies were quite uniform. In every instance the rats which were washed thoroughly survived longer than those which were treated by neutralization, and the local lesion at any given period after exposure to the caustic revealed less evidence of irritation than those which were treated by neutralization. The striking difference in the results of treatment by the two methods may be due to the additional trauma of heat of neutralization superimposed upon the already existing caustic burn. Heat of dilution must be considered in the rats which were treated by washing, but because of the method used, this heat was promptly carried away, and the sum total of the burn was that due to the caustic agent alone.

The question may be raised whether the results might not be further improved by neutralization of any of the alkali or acid which may still be present after vigorous washing. No experiments to determine this point have been made. It has been noted, however, that dilute acids and alkalies are not very active upon the skin. It is problematic whether the caustic in the slight dilution which is present after energetic washing can cause further tissue injury. It might be added that after such thorough reduction of the concentration that little damage might be anticipated from neutralization of the residual caustic.

CONCLUSIONS

1 Concentrated mineral and organic acids react with skin promptly. As the dilution of the acid increases there is a striking prolongation of the latent period. Concentrated hydrochloric acid is a much less vigorous caustic than either concentrated nitric or sulphuric acids. There is some evidence to suggest that trichloroacetic acid is absorbed like phenol and acts as a general protoplasmic poison.

2 Sodium and potassium hydroxide react with skin only after a prolonged latent period.

3 The results obtained in the treatment of experimentally produced alkali and acid burns were decidedly better when the caustic agent was removed by dilution with water than when rendered inert by neutralization.

4 When treatment by neutralization is employed, it should only be used after the maximal amount of the caustic has been removed by thorough washing.

BIBLIOGRAPHY

- ¹ Wells, H. G. *Chemical Pathology*, W. B. Saunders Co., Phila., 1914.
- ² Smith, A. K. *Treatment of Acid and Alkali Burns*. *Mod. Med.*, 1921, vol. III, p. 233.
- ³ Holland, J. W. *Inorganic Poisons* in Peterson, F., Haines, W. S., and Webster, R. W. *Legal Medicine and Toxicology*, vol. II, W. B. Saunders Co., Phila., 1923.
- ⁴ Sollmann, T. *A Manual of Pharmacology*, W. B. Saunders Co., Phila., 1918.
- ⁵ Fairbrother, H. C. *Poisoning from Strong Ammonia*. *St. Louis Med. and Surg. Journal*, 1887, vol. III, p. 272.

CONTRIBUTION TO THE STUDY OF BURNS, THEIR CLASSIFICATION AND TREATMENT

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THE multiplicity of methods and the difference in opinion in the management of burns shows that we have not yet mastered the question of their treatment. It is because of this that I have made a study of 83 consecutive cases of burns treated at the New York Post-Graduate Hospital. As a result of this study, I desire to call attention to a practical classification and a routine method of treatment that has given gratifying results over a tested period of years.

Classification—Burns have been classified, as to the agent causing them, into thermal, chemical, electric and radiant energy burns, as to the extent of penetration into the tissues, into first degree, or erythema forming, second degree, or blister forming, and third degree, or eschar forming. These classifications are explanatory and serviceable from an academic viewpoint, but as the practical trend in surgery is to think of every condition in terms of end-results, the classification of burns rearranged in accordance with this advance is a desideratum.

In observing cases of burns, it has impressed me that a division into two main types—those that will inevitably heal with scar formation and those that will heal without scar formation—immediately puts into the mind of the surgeon a practical classification in which the expected functional end-result is predominant. Thus, under this classification, we recognize a Type 1 or scar forming, and a Type 2, or non-scar forming burn. This classification also, in terms of treatment, tells us that a Type 1 burn will require special treatment to minimize scarring, whereas a Type 2 burn will require little thought to the possibility of scar formation and will necessitate only treatment directed to relieve the inflammation and pain. Under Type 1, is the third degree, and under Type 2, are the first and second degree burns of the old classification. A first degree burn, unless extensive often requires household remedies only, so that this consideration concerns itself really with the second and third degree burns of the old system, which eventually come to the surgeon for treatment.

Further classification of these two types follows a division into three stages based upon the pathological changes going on in the burned area, and treatment is directed to relieve the dominant symptoms in each stage. These stages are not clear-cut. They merge into one another, but for practical purposes they are the first, inflammatory or dermatitis stage, characterized by an immediate reaction to the causative trauma manifested by all the classi-

cal signs of inflammation, the second, exudative or secretory stage during which the body casts off the dead tissues in the form of a slough, and the third, granulating or reparative stage, during which nature attempts to bridge the loss in continuity of the tissues. Each of these stages has a more or less definite duration time, and I have found them to be 2 to 4 days for the first stage, 6, 10 or more days for the second stage, and weeks for the last stage, depending upon the size and depth of the area burned and the form of treatment applied.

Pathology—Pathologically a Type 2, or non-scarring burn varies from a simple hyperæmia of the area without loss of structure to a more severe inflammation and congestion with the early and rapid formation of blisters of various size and extent. The bases of these blebs consist of inflamed skin and the contents of amber-colored serum, which is fluid in the early stages and gelatinous later. The blood-vessels are congested and a few are thrombosed. The stratum germinativum is markedly swollen and covered by a layer of small leucocytes. In this type of burn, without the

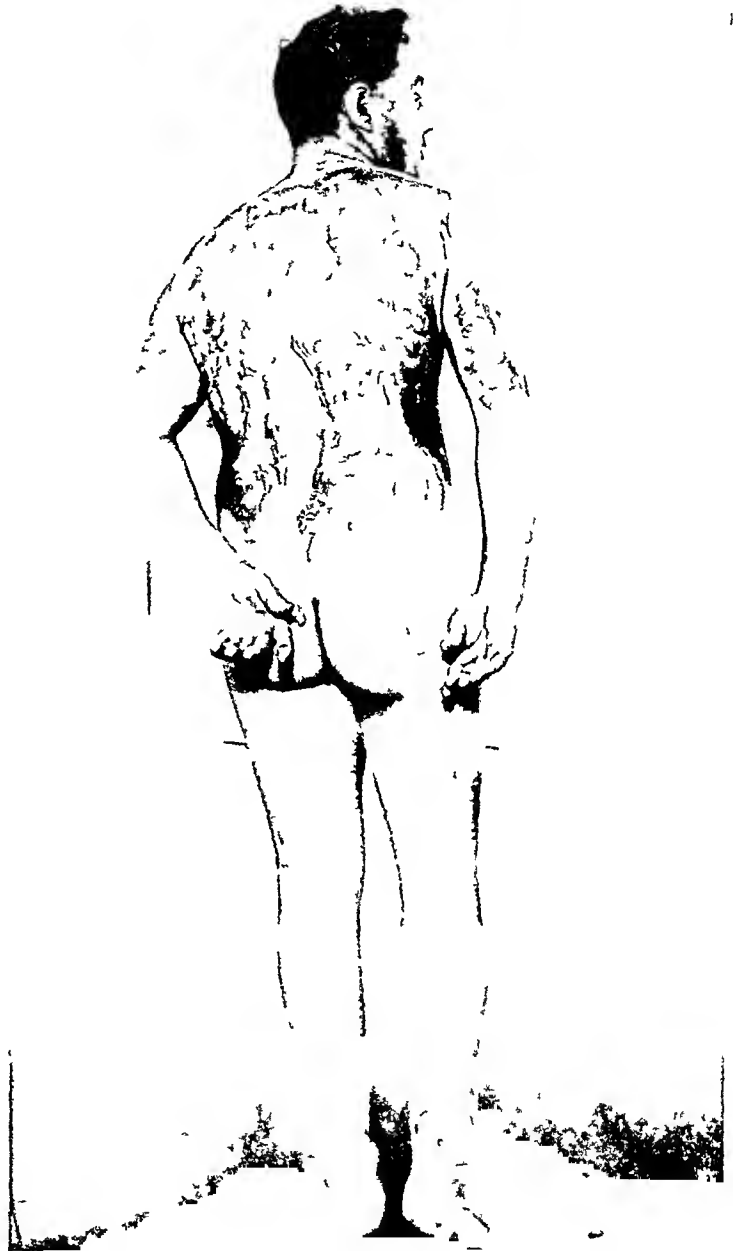


FIG. 1.—Type II burn ten days after injury

superimposition of infection, there is a retrogression of the signs of inflammation with a return to normal of the skin in from ten days to three weeks without leaving a scar. A discoloration or pigmentation, however, may last for a long time. If the burn is of the Type 1, or scar forming variety, there is a destruction of the whole skin layer usually involving the underlying structures. There is a coagulation of the cell contents, destruction or thrombosis

of the blood-vessels of the corium, and the intercellular spaces are filled with broken-down albuminous products. In response to this severe trauma there is a marked inflammatory reaction together with a vasodilatation and alteration in the vascular walls, resulting in an increased permeability of the vessels with consequent loss of circulatory fluids by a pouring out through the vessel walls. This also causes an increased concentration of the blood in extensive burns and Underhill¹ has called attention to this blood concentration as the result of pathologic exudation which accompanies the vasodilatation.

Healing cannot take place until this dead tissue is removed or allowed to slough away. From this necrotic tissue, due to heat coagulation, there is absorbed into the blood stream a toxin, due very likely to tissue autolysis which is the cause of the toxic or secondary shock. Experimentally, Robertson and Boyd² have shown that a substance is produced in burned tissues (in larger quantities in extensive burns of the skin than in those of other tissues) which circulates in the blood, either in or closely adsorbed to, the red blood cells, and which causes the toxic shock and, in some cases, death. Toxic material is produced in increasing amounts following the burning of the tissues until the interval from 24 to 36 hours after the injury. It is produced only as the result of burning living tissues. The toxin is most highly concentrated in solutions of corpuscles suitably treated, and least in the serum. Chemically, this toxin consists of primary and secondary proteoses. Like snake venom, it is made up of two portions, a necro-toxic and a neuro-toxic substance. The former is not destroyed by heat and is diffusible, the latter is thermolabile and colloidal. Robertson and Boyd³ found no evidence of the formation of antibodies against the burned toxin. Extracts of burned living skin were toxic. Extracts of skin burned post-mortem were innocuous. The contents of burn blisters were not toxic.

Invariably, in all burns of the Type I variety, infection supervenes and if no toxic shock is present, the inflammatory reaction becomes aggravated usually after 24 to 72 hours, corresponding to the incubation period of the associated infective organisms, and instead of a simple inflammation, the result of an irritant, we have now to deal with a superficial infected wound and the clinical picture henceforth will be influenced by the extent of the burn and the type and virulence of the infective organism. The organisms we most commonly found were the pus cocci. Because of the frequency of this associated infection, Moorhead⁴ aptly defines a burn as "an infected wound due to heat."

Of burns, those produced by moist heat, such as steam or hot liquid, we have found to be the most penetrating, while those produced by flame and electricity we have found to be the more superficial. It has been our experience that the extent of the burned area was of far more importance as to prognosis than its depth. This is in accord with McLeod⁵ who further writes as regards prognosis, that a burn of even mild degree may cause a

fatal issue and that this is almost inevitable if the area affected is more than one-third of the total body surface

Burns by electricity are always associated with flame production so that there is an injury to the deeper tissues by the electric current plus the burn of the skin by the flame. The latter produces a singeing of the skin, as it were, and if the current is not very high we have found the resultant burn readily amenable to treatment. A common site for this type of burn is the face or hands, such as occurs in electric welders and workers on the tracks of electric railways. Schridde⁶ has found that burns produced by electricity are histologically identical with those provoked by the application of great heat. Of the commoner gross pathologic findings in death due to burns, degenerative changes in the liver, spleen, kidneys, bone marrow and particularly, the adrenals, were the outstanding findings of Olbycht⁷ and Weiskotten⁸. Recently, Hartman, Rose and Smith⁹ have demonstrated an increased

FIG 2—Same as Fig 1 nineteen days later showing pigmentation left after a Type II burn

output of epinephrin from the suprarenals within a few minutes after burns occur, even in conditions of anaesthesia. The increase may persist for several hours. Under such circumstances, a depletion of epinephrin and of lipoids in the suprarenals may result. The demonstration that burns cause an excessive activity of these glandular structures may help to explain some of the manifestations that have been difficult to interpret. The severe degenerative changes described have been compared to the demonstrated

occasional comparable effects of diphtheria intoxication. Death, when due to burns, is from traumatic shock when occurring in the first 24 hours, and from toxic shock when occurring in the second to the fourth day. Blumenau¹⁰ reports 43 per cent of deaths in his series as occurring during this period of toxæmia.

Healing and repair of burns on account of the superficial location is slow, and a large burn may take months to heal unless hastened by skin grafting. The same laws governing repair are active in healing after burns as in wounds made by the scalpel or other instrument, except that the resultant scar, instead of being distributed in the depths of the tissues as in abdominal wounds or deep wounds elsewhere, is spread out on the surface and almost entirely visible. By virtue of this distribution, shrinkage of burn scars is responsible for marked contractures and deformities, and the treatment of a burn should always be with a mind open to this possibility.

Clinical Findings—Clinically, burns manifest a complex of symptoms referable to the site of the lesion and also as to the general effects. Of the general effects, traumatic shock is the earliest and most important and requires prompt measures to tide the patient over it. It may be a concomitant of either type of burn, if extensive. We have often observed it in a Type 2 burn of the face where the extent and intensity of the burn did not warrant so profound a reaction and we believe the marked reaction following burns in this area to be a nervous manifestation. Bearing in mind the anatomy of the skin with its rich distribution of sensory nerves, we can readily understand that those parts of the body that are nervously unstable will give a more marked reaction. The face, neck and upper chest, being normally the blush area and nervously unstable, are easily influenced by traumatic as well as by other stimuli. Shock occurring after the first 36 hours is toxic in origin. The toxæmia responsible for this may last 2 to 4 days and manifest itself by rise in temperature and pulse rate, drowsiness or restlessness, often vomiting and, in children, convulsions may occur. It is in no way related to the infection that supervenes, but is the result of a toxin liberated by the autolytic process going on in the burned tissues, as explained under the caption of Pathology. Later on, the daily rise in temperature and secondary anemia that follows are due to absorption from a widespread surface infection.

Of the local symptoms, pain is by far the most conspicuous and troublesome, often requiring large doses of morphia for its relief. The urinary findings in our series were mostly negative, with a few cases showing traces of albumin. When appearing, this was a constant finding only during the dermatitis stage, gradually becoming less and less as the burn enters the secretory stage. The clinical picture during this stage is that of a more or less widespread wound infection, secreting a purulent or sero-purulent discharge covered with areas of sloughed tissue, ranging in color from a light yellow to a brown or black. The edges of the wound show a bluish border of epithelium growing toward the centre in an attempt at healing. In the last,

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of granulating stage, the appearance is that of a clean granulating wound which may show a tendency toward heaping of the granulations, especially near the centre. There is less of a purulent and more of a serous discharge now and the area continues to grow smaller under the advance of the epithelial covering spreading from the periphery.

Our series presented an increased concentration of the blood, but not as much as reported by others. There was an increase in the nitrogenous waste products, more marked in cases terminating fatally. The chlorides were diminished but not sufficiently to make this a basis of therapy. Marked changes in the liver were evidenced by an increase of bile pigment in the blood and output of urobilin in the urine which, we believe, will prove of importance in therapy.

<i>Total number of cases in this series, 83</i>		<i>Causative trauma</i>	
Type 1 variety (scar-forming)	16	Electricity	47
Type 2 variety (non-scarring)	56	Hot liquids	17
Type 1 and 2	11	Flame	8
		Gasoline	6
		Steam	4
		Chemicals	1
<i>Sites</i>		<i>Age incidence in decades</i>	
Face	17	First	8
Face and hands	25	Second	4
Chest and back	6	Third	29
Lower extremities	12	Fourth	19
Upper extremities	17	Fifth	18
Abdomen	2	Sixth and over	5
More than one-fourth of body	4		
<i>Time elapsed between receipt of burn and hospital admission</i>		<i>Cases requiring operation</i>	
One hour	6	Skin graft	11
Less than one day	23	Debridement	7
One day or over	19		4
Less than one week	25	<i>Complications</i>	7
Over one week	4	Tetanus	3
Over one month	6	Osteomyelitis	4
		<i>Deaths</i>	3
		Tetanus	1
		Toxic shock	2

TREATMENT

In approaching the problem of treatment in burns, we considered the physiological functions of the skin which briefly stated are—sensation, excretion, temperature regulation and respiration. We attempted to adopt measures that would not further interfere with the above functions in an already damaged skin. For this reason, we were early advocates of the open air exposure and radiant heat methods of treatment in burns. We dislike to employ any occlusive type of dressing such as the paraffine or ambrine methods, because we believe them to be non-surgical and unnecessary. Since we have adopted the treatment outlined below, we find the necessity for

skin grafting to be less frequent, and in our series of 83 cases, this operation was done only seven times. Further, an occlusive dressing shortly becomes a pus poultice in an actively secreting infected wound tending to retain the secretion, thus promoting the absorption of toxic products.

In our treatment we follow the same subdivision of the stages of burns as outlined under the caption of Pathology, and attention is directed to both the local and general manifestations of the case.

During the first, or toxic stage, shock and toxæmia are the early mani-



FIG. 3—Type I and II burn eight days after injury

festations. Shock is combated by placing the patient in the "shock position," applying external heat, forcing fluids and relieving pain. External heat may be applied either in the form of radiant heat from electric lights attached to a cage applied over the patient with the lights no nearer than 12 inches from the body. This need not be a highly complicated piece of mechanism and can be readily improvised at the bedside. If electricity is not available, direct heat may be applied by means of hot water bags or automobile inner tubes filled with hot water and placed at the sides of the patient, or hot compresses. Fluids are forced by every avenue of entrance—mouth, rectum, infusion, or hypodermatoclysis. Fluids at this time serve a double purpose—maintaining the circulation and lessening dehydration, and diluting the poisons in the blood stream. Because of the tendency to acidosis, weakly alkaline

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fluids are used, and for this purpose, a 5 per cent sodium bicarbonate solution has given us very good results. The pain associated with the initiating trauma is responsible for this primary shock, and for this reason, sedatives continuously and often in large quantities are indicated. Stimulation for cardiac or respiratory failure are indicated as the necessity for their usage arises.

Locally, the burn is regarded as a wound due to heat, and as such is

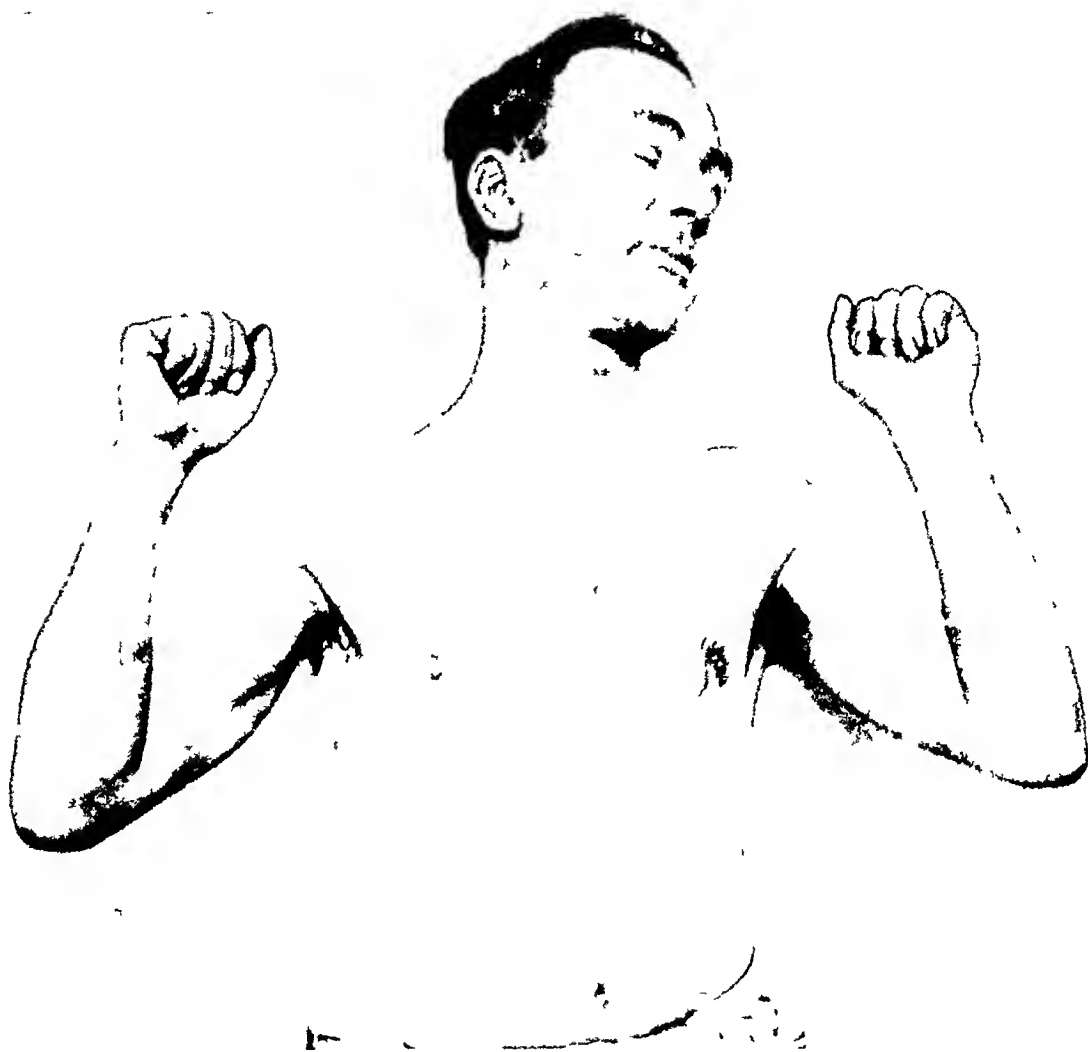


FIG. 4—Same as Fig. 3 three weeks later

dealt with surgically as other wounds. Therefore, sterilization with tincture of iodine, one-half strength, is primarily instituted, followed by the application of a wet dressing of a sterile solution of sodium bicarbonate, 10 per cent. This use of iodine seems at first paradoxical, in view of the excruciating pain associated with burns, but its rationale is seen when we remember that the necrotic tissue is insensitive and that the pain is due to the injury and irritation of the nerve endings lying beneath.

The dressing is made of loose fluffs of gauze in the folds of which several small soft rubber tubes of the Carrel type or plain tubes with fenestrations in them are incorporated and are allowed to protrude beyond the bandage.

This allows of easy saturation of the dressing periodically without removal of the bandages or the flooding of the bed. This bicarbonate dressing is kept constantly wet and maintained for 24 to 48 hours, by which time the shock, if present at the beginning, will have either entirely disappeared or become greatly ameliorated. The dressing is then completely changed by soaking and a new dressing of similar type is applied and kept on for 2 or 3 days longer, by which time the acute inflammatory character of the wound changes to the milder appearance of the second or secretory stage. At this time, as stated before, the secondary or toxic shock is apt to appear. For



FIG. 5 —Burn of hand, seven days after injury

this reason, fluids are still pushed. If it should appear, in spite of treatment, blood transfusion will prove of decided benefit. We have had no occasion to use the exsanguination-transfusion treatment, as advocated by Robertson and Boyd¹¹ and regard it as a heroic form of treatment.

All dressings are now removed, blisters are opened aseptically, and the burn is exposed to sunlight during the day. This is done by exposing the wound to the direct sunlight beginning with 5 minutes every 2 hours and increasing to 20 minutes, and in the intervals, to the air. If sunlight is not available, ordinary electric lights may be suspended at a distance of 12 inches from the body and kept there for a period beginning with 10 minutes every 2 hours and increasing to 30 minutes. At night, a wet dressing of sodium bicarbonate solution is applied. Continued use of alkaline dressings is employed to soften the crusts which form because of the air exposure, and to check the process of autolysis going on in the burned tissue. Wiener¹² has shown that the intracellular proteoses act only in a faintly acid medium and that their activity is entirely checked by a slight shift to the alkaline. Where the burn is extensive we have found sodium bicarbonate baths of great benefit in helping in the separation of sloughs. This is continued until active secretion ceases, which may be from 6 to 10 days.

In children where acidosis is apt to be more marked and where late shock is not an uncommon occurrence, alkaline baths have proven of decided value.

Vogt,¹³ Robertson and Boyd¹⁴ and others have demonstrated that the early complete removal of the burned tissues will prevent the development of toxæmia. Others have advised the removal of as much of the necrotic tissue as possible, under a general anæsthetic or large doses of morphine, thus removing the source of the toxæmia. The use of these energetic measures is advocated after the primary period of collapse.

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There are cases, however, in which the vitality of the patient might be taxed to such a degree by this therapy that a case with an otherwise favorable prognosis might conceivably end fatally. Further, the idea of the administration of an anæsthetic cannot be accepted too lightly, in view of the fact that there is congestion of the lungs as well as of the abdominal viscera. We have found the use of sodium bicarbonate dressings and baths, if not as heroic, to have proven adequately efficacious at this stage of the burn.

More recently Davidson¹⁵ has been using a 5 per cent aqueous solution of tannic acid to coagulate the necrotic tissue, and reports good results.

He claims that the tannic acid coagulates the injured tissues only, forming a membrane over the burned area. One is not entirely certain, however, whether this tanning process does not tan devitalized tissues which might otherwise have recovered, thus increasing the extent of the slough. Further,



FIG. 6.—Same patient as in Fig. 5 seven weeks later.

the formation of a crust invites infection not only of the aerobic, but particularly of the anaerobic organisms, predisposing to tetanus infection which is not as infrequent in burns as one would suppose, there being 3 cases of tetanus in our series, with one death. Also, the presence of the acid medium would promote the process of autolysis which we aim to arrest. Because of these possibilities, this form of therapy lends itself to selected cases only and cannot be used in the presence of infection.

After active secretion ceases, which may be from 6 to 10 days, the burned area assumes the characteristics of a granulating wound and the treatment henceforth consists of the sunlight or electric light exposure during the day, and at night a dressing of equal parts of sterile olive and camphorated oil applied on flat pieces of gauze. This dressing, applied at this time, is not painful and the camphor in it acts both as an active stimulant for the growth of granulations and as a germicide. In addition to this, we have been using with gratifying results, exposure to the ultra-violet rays, as follows. After removing all crusts and pus from the surface of the burn, the area is exposed to the air cooled type of lamp, or alpine lamp, at a distance of 24 inches and an exposure time of 3 minutes. The distance is decreased at each treatment, which is every other day by 4 inches, until 12 inches is reached. The exposure time is then increased—a minute every treatment until 5 minutes are reached and this is maintained until after epithelization is complete. The effect is a sterilization of the wound, drying up of the secretions, and hastening of granulation and epithelization. To further hasten the

growth of epithelium, we use a dressing of a dram of scarlet red to an ounce of sterile olive oil, and strapping of the periphery of the wound with flamed adhesive plaster

In cases of Type 1 burn where the absorption from a widespread area over a prolonged period of time produces an exhaustion of the patient, periodic transfusions are of marked benefit and enhance the processes of repair

During all these stages, the postural position of the patient is of the greatest importance. If the burn is situated near any of the folds or creases of the body, these should be mobilized early, and where immobilization is indicated, on account of excessive pain, it should always be in a position of maximum give, *i e*, in complete abduction and extension of the part. Although contractures are spoken of as a late manifestation of burns, it is at this time that they can be prevented, hence the importance of posture as a prophylactic measure.

The treatment outlined above holds true for burns anywhere in the body, except the face. Here the first stage is carried out as above, but when exposure to the sun and light is instituted, the night dressing consists of a 10 per cent boric acid ointment. For the eyes, 10 per cent argyrol installations and boric acid lavages are early instituted. To prevent contractures, by means of mobilization of the face, early movements should be encouraged and blowing out the cheeks, wrinkling the forehead and the use of chewing gum have proven helpful.

Skin Grafting—In following out the above routine of treatment, we have found the use of skin grafting becoming more and more an indication in cases that have had their preliminary treatment elsewhere. The type of graft to be used is largely a matter of individual choice or custom of the surgeon. We have been in the habit of applying the following rule. Where the burn is extensive in area but not in depth, we use the Thiersch type of graft, where the area is small and shallow, the pinch type, and where the burn is deeply penetrating, the flap type of graft. In all cases, wherever possible, auto-graft is desirable. Where this is not possible, a donor of the same blood grouping will give a better chance of 'take'.

Debridement should be used in selected cases only, not as a routine. In burns, it has very much the same indication as in compound fractures and must be chosen with a good deal of care. It is indicated in Type 1 burns where the slough is localized. If the burn is too extensive, it subjects the patient to too great a shock. In children it should be done very, very rarely. Debridement as commonly practiced, is sacrificing of tissues. Skin grafting is repair. Therefore, it is a hospital problem and, indeed, a problem in plastic surgery.

CONCLUSION

1. Classification of burns into scarring and non-scarring types constantly keeps the functional end-result in mind.

2. The knowledge of a Type 1 or scarring burn, will require special

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treatment to minimize scar, whereas a Type 2, or non-scarring burn will not require special treatment, makes this classification of practical importance

3 The open air and radiant light method of treatment have proven adequate and serviceable over a prolonged period of time

4 It has lessened scar formation and decreased the frequency of skin grafting

5 It has taken burns from the Carron oil, salve and fertilizer type of management and placed their treatment upon a surgical basis

6 The open air method of treatment makes the resultant scar more uniform in appearance and more resistant to the rigors of climate

7 Debridement should be employed only after careful study and consideration of the individual case

8 There are two types of shock—primary or traumatic, and secondary or absorptive—due to anaphylaxis from protein-split products. Late shock is due to absorption from infection, the organism usually being a coccus

9 An important part of the treatment is prevention of infection, irregular scars and contractures

BIBLIOGRAPHY

¹ Underhill, F. P., Carrington, S. L., *et al*. Arch Int Med, 1923, vol. LXXII, p. 31

² Robertson, B., and Boyd, G. L. J. Laboratory and Clinical Med., 1923, vol. IX, No. 1

³ *Idem*

⁴ Moorhead's Traumatic Surgery, Chapter, XVI

⁵ McLeod, J. M. H. Oxford Surgery, N. Y., Oxford Univ. Press, 1919, vol. II, p. 438

⁶ Schriddle, H. Klinische Wochenschrift, Berlin, December 23, 1923

⁷ Olbrycht, J. Rev. de Med., Par., 1924, vol. XLI, p. 81

⁸ Weiskotten, H. G. Histopathology of Superficial Burns. J. Am. M. Assn., 1919, vol. LXII, p. 259

⁹ Hartman, F. A., Rose, W. J., and Smith, E. P. The Influence of Burns on Epinephrine Secretion. Am. J. Physiol., vol. LXXVIII, p. 47, September, 1926

¹⁰ Blumenau, N. R. Russky Vroch., vols. VI, XVI, p. 406, 1863

¹¹ Robertson, B., and Boyd, G. L. Am. J. Diseases of Children, February, 1923, vol. XXV, pp. 163-167

¹² Wiener, H. C. Centralbl. f. Physiol., 1905, vol. XL, p. 349

¹³ Vogt, E. Ztschr. f. exper. Path. u. Therap., 1912, vol. XI, p. 191

¹⁴ Robertson, B., and Boyd, G. L. J. Laboratory and Clinical Med., 1923, vol. IX, No. 1

¹⁵ Davidson, E. C. Surg., Gyn. and Obst., August, 1925, vol. XLI, No. 2

POST-OPERATIVE WATER METABOLISM AND THE INTRADERMAL SALT SOLUTION TEST*

A PRELIMINARY REPORT

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IN THE post-operative treatment of patients one of the most important problems is that of the water metabolism of the body Dean Lewis¹ last spring said, "there is a tendency to administer too great amounts of

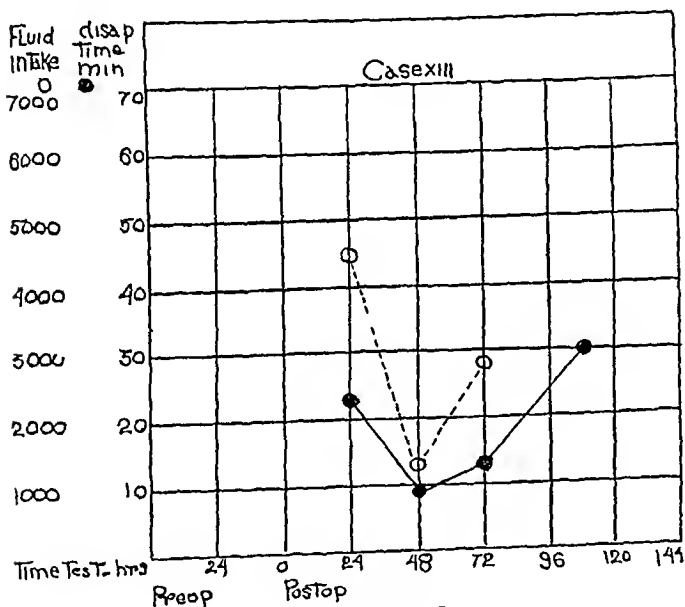


FIG 1—Case XIII

fluid, and some one should attempt to determine the amounts required in different groups of cases to maintain the water balance" It is a problem, therefore, how much water should be given post-operatively in the various types of cases and what is the most satisfactory method of giving it in the individual case

There are a number of tests that are used or can be used in determining

the degree of dehydration that exists in the organism The amount of water that can be absorbed by the various routes is a rough indication of the hydrophilic state of the tissues The clinical symptom of thirst, of course, is an indication of the need of the body for water This is grossly unreliable, however, for the correlation between the degree of thirst and the amount of tissue dehydration is not definite, and in the second place the liberal use of morphine masks subjective symptoms The amount of urine voided is probably the most useful test of the water metabolism There are objections to it, however The determination of the hæmoglobin percentage of the blood or the refractorimetric estimation of the plasma proteins are other methods applicable to this problem It is conceivable, however, that a considerable degree of tissue dehydration can exist before the water content of the blood

* Read before the Philadelphia Academy of Surgery, December 6, 1926

POST-OPERATIVE WATER METABOLISM

is altered. A method which seemed to offer the possibility of objective measurement of the need of the tissues themselves for water seemed to present itself in the disappearance time of an intradermally injected quantity of salt solution.

The mechanism of the test is disputed. It is bound up with the problem of œdema in general. Some workers have explained it on the basis of Martin H. Fischer's² work, who pointed out that fibrin absorbed more water in an acid solution than in a neutral one, and who offered an explanation of nephritis, œdema, and other pathological processes on these basic facts. There are certain fundamental, experimental objections to this theory.

Another theory that perhaps explains the phenomenon in our type of cases, depends on the balance between capillary pressure and the osmotic pressure of blood.^{3, 4}

In 1923, McClure and Aldrich⁵ first described the intradermal salt solution test. Their method was to inject intradermally 0.2 cc of an 0.8 per cent sodium chloride solution and note the disappearance time of the wheal. They found that

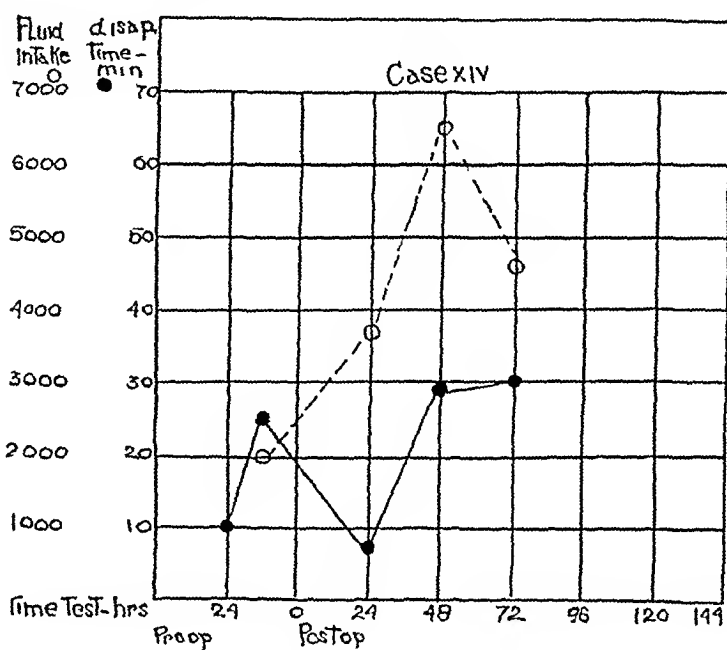


FIG. 2—Case XIV

the normal disappearance time was roughly sixty minutes, but that in œdematous conditions (nephritis, cardiac decompensation, anaemia) the disappearance time was decreased to as low as three and seven minutes in two cases. Since then, reports by a number of investigators have appeared, applying this test to a variety of conditions. In nephritis⁶ it was shown that a reduction in disappearance time preceded the clinical evidence of œdema and that an increase in the reduced disappearance time preceded the disappearance of œdema. In the toxæmias of pregnancy⁷ a decreased disappearance time has been demonstrated, and the more reduced the disappearance time the severer the case. Patients with scarlet fever,⁸ diphtheria and pneumonia⁹ have been found to have a reduced disappearance time the reduction being parallel to the severity of the intoxication. The administration of thyroid extract to myxœdematous patients has been shown to decrease the disappearance time of the wheal.¹⁰

Experimental interference with the peripheral circulation in rabbits was found to decrease the disappearance time.¹¹ The normal time of disappearance was found to be reduced in such conditions as diabetes with gangrene, endarteritis obliterans, intermittent claudication and arterial emboli.¹² Read-

ings of ten minutes, for example, were found only in tissues immediately above areas of gangrene, while readings between ten and twenty-five minutes were held to be suggestive of developing gangrene. With varicose veins the

rate of disappearance varied according as the member was elevated or dependent. A case was reported¹⁷ in which it was difficult to tell whether the condition of the patient was due to shock or hemorrhage after a crushing injury to the thigh. A normal disappearance time of the intradermal salt solution in the wheal seemed to rule out circulatory damage to the member and the condition was held to

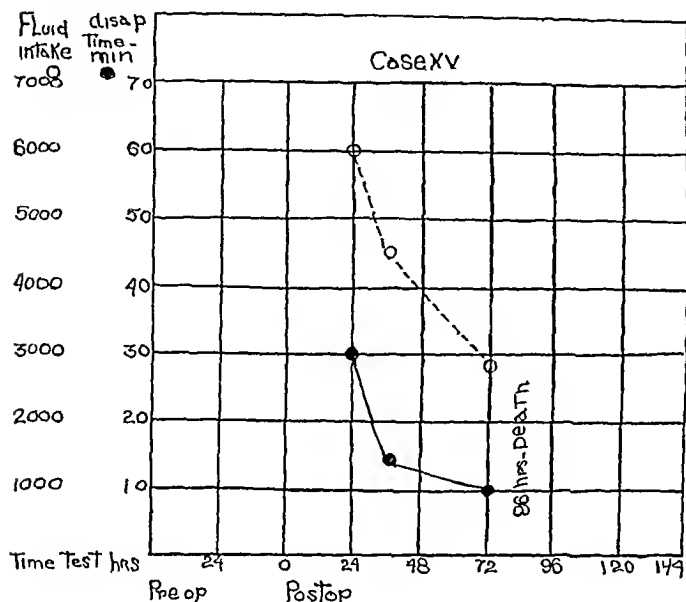


FIG 3—Case XV

be due to shock. Autopsy proved there had been no rupture of the vessels. A circulatory disorder masquerading as a traumatic condition was demonstrated by the test. We see, therefore, that although the test has been used in surgical conditions, it has not been used primarily to determine the nature of the water balance of the body.

The technic employed by us follows. From a tuberculin syringe 0.5 cc of a sterile 0.85 per cent sodium chloride solution is injected intradermally into the skin overlying the peroneal tendons directly above the external malleolus. Two wheals are made about 2 cm apart and the time

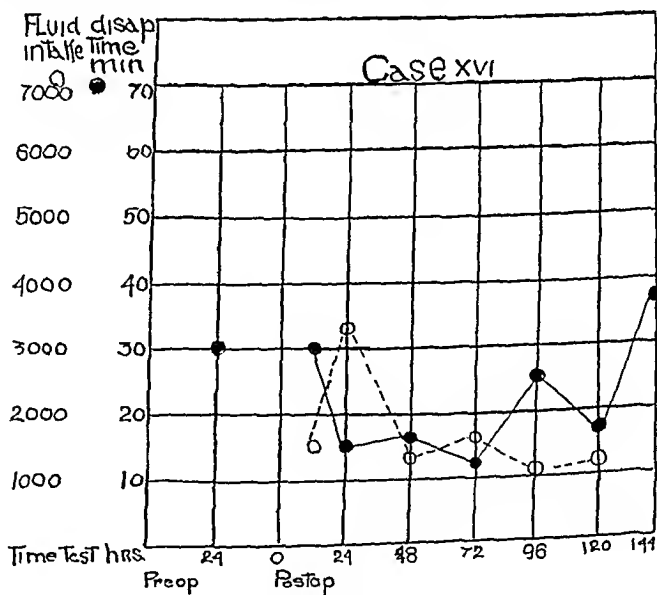


FIG 4—Case XVI

required for their disappearance to light touch "unassisted by inspection" is determined. We found that, in a small series of normals with our method of injecting only 0.05 cc, the disappearance time was about thirty minutes—although occasionally some lasted as long as fifty or sixty minutes. Below

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twenty-five to thirty minutes we felt was abnormal, and anything below ten minutes was distinctly abnormal. The reason we elected to use such a small wheal was because of the time-saving factor on a busy surgical service. Our normal figure therefore, of thirty minutes is much shorter than that used by previous observers. It is possible, too, that the end point of a smaller wheal is less satisfactory than a larger one. In interpreting the disappearance of the wheal, one must bear in mind the other conditions beside dehydration in which there is a decrease in the wheal disappearance time, *viz*, circulatory disturbances (such as occur in emboli, thrombosis, arteriosclerosis, thromboangitis obliterans, and diabetes), conditions producing œdema (cardiac and renal disease), toxic conditions (pneumonia, scarlet fever, diphtheria, toxæmias of pregnancy), and anæmias. The chloride metabolism in intestinal obstruction may be an additional factor.

The small number of observations that follow are offered merely as suggestions. We are by no means sure of the mechanism involved in this test or its ultimate value as a test for body dehydration.

CASE I—F F, male, age sixty-eight years. Symptoms of repeated hematemesis for several days. Diagnosis: Duodenal ulcer. X-ray uncertain. Unoperated. Disappearance time twenty minutes.

CASE II—M M, male, age twenty-four years. Diagnosis: Right inguinal hernia.

Time of Test	Wheal Disappearance Time
Pre-operative	30 + minutes
Post-operative, 24 hrs	35 + minutes

CASE III—R G, male, age twenty-six years. Diagnosis: Right inguinal hernia.

Time of Test	Wheal Disappearance Time
Pre-operative	30 + minutes
Post-operative, 24 hrs	35 + minutes

CASE IV—G G, male, age thirty-five years. Diagnosis: Duodenal ulcer, chronic appendicitis. Operation: Oversuture of ulcer, posterior gastro-enterostomy, appendectomy.

Time of Test	Wheal Disappearance Time	Intake	
Pre-operative	32 minutes	Hypodermoclysis	Enteroclysis
Post-operative, 35 hrs	30 minutes	3250 cc	4000 cc

CASE V—E L, female, age fifty years. Diagnosis: Carcinoma of stomach. Operation: Subtotal gastrectomy, Posterior Polya.

Time of Test	Wheal Disappearance Time	Intake	
Pre-operative	45 minutes	Hypodermoclysis	Enteroclysis
Post-operative, 34 hrs	35 minutes	4000 cc	3000 cc

CASE VI—M L, female, age fifty-seven years. Diagnosis: Right pyonephrolithiasis. Operation: Right nephrectomy and transfusion.

Time of Test	Wheal Disappearance Time	Intake	
Pre-operative	50 minutes	(Patient bled profusely—trans-	
Post-operative, 5 hrs	13 minutes	fusion 500 cc	intravenous
		500 cc	
Post-operative, 24 hrs	15 minutes	Total intake	3400 cc
Post-operative, 13 days	30 minutes		

APPEL AND BRILL

CASE VII—L M, female, age fifty-seven years Diagnosis Pernicious anemia
 Chronic calculous cholecystitis Operation Cholecystectomy, splenectomy Transfusion,
 Hb, 37 per cent, red blood-cells, 2,300,000

Time of Test	Wheal Disappearance Time	Intake
Pre-operative	2 minutes	Blood transfusion, 500 c c
Post-transfusion	5 minutes	
Post-operative, 10 hrs	8 minutes	3000 c c (?)
Post-operative, 11 days	4 minutes	1500 c c per day (Hb, 51 per cent, red blood-cells, 2,600,000)

CASE VIII—V M, female, age eighteen years Diagnosis Post-operative adhesions
 Operation Exploratory laparotomy, lysis of adhesions

Time of Test	Wheal Disappearance Time	Intake
Pre-operative	?	
Post-operative, 30 min	50 minutes	
Post-operative, 24 hrs	50 minutes	2500 enteroclysis
Post-operative, 72 hrs	25 minutes	650 mouth (24 hrs)

CASE IX—H S, female, age forty-five years Diagnosis Acute calculous cholecystitis
 Operation Cholecystectomy

Time of Test	Wheal Disappearance Time	Intake
Pre-operative	?	
Post-operative, 30 min	45 minutes	
Post-operative, 24 hrs	35 minutes	3500 c c enteroclysis
Post-operative, 72 hrs	30 minutes	1250 c c by mouth (24 hours)

CASE X—R S, female, age thirty-six years Diagnosis Chronic appendicitis
 Operation Appendectomy

Time of Test	Wheal Disappearance Time	Intake
Pre-operative	32 minutes	
Post-operative, 30 hrs	55 minutes	4500 c c enteroclysis
Post-operative, 52 hrs	75 minutes	210 c c (mouth), 2500 enteroclysis
Post-operative, 72 hrs	55 minutes	(?) intake by mouth

CASE XI—M S, female, age nineteen years Diagnosis Trophœdema of left foot
 Operation Exploratory laparotomy

Time of Test	Wheal Disappearance Time		Intake
	Foot	Leg	
Pre-operative	2 min	18 min	
Post-operative, 24 hrs	2½ min	45 min	600 c c by mouth
Post-operative, 48 hrs	3½ min	40 min	?
Post-operative, 72 hrs	19 min	40 min	?
Post-operative, 96 hrs	20 min	20 min	?

CASE XII—C E, male, age sixty-three years Diagnosis Carcinoma of stomach
 Operation Exploratory laparotomy

Time of Test	Wheal Disappearance Time	Intake
Pre-operative	20 minutes	
Post-operative, 6 hrs	17 minutes	600 c c enteroclysis
Post-operative, 24 hrs	17 minutes	2000 c c enteroclysis
Post-operative, 48 hrs	?	
Post-operative, 72 hrs	42 minutes	Fluid by mouth (?)
Post-operative, 96 hrs	30 + minutes	

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CASE XIII—S K, female, age forty years Diagnosis Jaundice, unknown etiology
Operation Choledochotomy, cholecystostomy

Time of Test	Wheal Disappearance Time	Intake	
Pre-operative	?	Enteroclysis	Hypodermoclysis
Post-operative, 24 hrs	23 minutes	2500 c c	2000 c c
Post-operative, 48 hrs	9 minutes	1290 c c by mouth	
Post-operative, 72 hrs	13 minutes	2820 c c by mouth	
Post-operative, 108 hrs	30 minutes	?	

CASE XIV—M C, male age forty-eight years Diagnosis Carcinoma of sigmoid
Operation First stage, Mikulicz

Time of Test	Wheal Disappearance Time	Intake	
Pre-operative	10 minutes		
Pre-operative, 12 hrs	25 minutes	2000 c c hypodermoclysis	
Post-operative, 24 hrs	7 minutes	3700 c c hypodermoclysis (+ + vomiting)	
Post-operative, 48 hrs	29 minutes	Hypodermoclysis Mouth Intravenous	
		4300 c c 1200 c c 1000 c c	
			(+ + vomit)
Post-operative, 72 hrs	30 minutes	3200 c c 900 c c 500 c c	

NOTE—Directly after intravenous glucose injection patient had a chill and the temperature, pulse, and respiration rose to 104.2, 140, 38, respectively. The wheals disappeared in four minutes, but the following morning disappeared in thirty minutes.

CASE XV—A K, female, age thirty-six years Diagnosis Carcinoma jejunum
Operation Entero-enterostomy

Time of Test	Wheal Disappearance Time	Intake		
Pre-operative	?	Hypodermoclysis	Enteroclysis	Mouth
Post-operative, 24 hrs	30 minutes	3500 c c	2500 c c	
Post-operative, 36 hrs	14 minutes	4000 c c	500 c c	60 c c
Post-operative, 72 hrs	10 minutes	2500 c c	Transfusion,	350 c c
Post-operative, 86 hrs	Death			

CASE XVI—E Mc, female, age seventeen years Diagnosis Haemolytic ictero-anæmia Operation Splenectomy

Time of Test	Wheal Disappearance Time	Intake	
Pre-operative	30 minutes	Enteroclysis	Mouth
Post-operative, 12 hrs	30 minutes	1500 c c	80 c c
Post-operative, 24 hrs	15 minutes	3350 c c	?
Post-operative, 48 hrs	16 minutes		1320
Post-operative, 72 hrs	12 minutes		1680
Post-operative, 96 hrs	25 minutes		1080
Post-operative, 120 hrs	17 minutes		1230
Post-operative, 144 hrs	37 minutes		740 -- (?)

CONCLUSIONS

- 1 There is frequently a reduced disappearance time of the intradermal salt solution wheal, post-operatively
- 2 We have suggested this test as a method for determining the need of the tissues for water post-operatively
- 3 This test may be used to show the adequacy of the post-operative introduction of fluids by the various methods

BIBLIOGRAPHY

- ¹ Lewis, D Post-operative Treatment Boston M and S Jour, vol cxciv, pp 913-920, May 20, 1926
- ² Fischer, M H Œdema and Nephritis Ed 3, New York, John Wiley and Son, Inc, 1921
- ³ Starling, E H Human Physiology Ed 3, 1920
- ⁴ Schade, H, und Claussen, F Zeitschr f Klin Med, 1924, vol c, p 363
- ⁵ McClure, W B, and Aldrich, C A Time Required for Disappearance of Intradermally Injected Salt Solution J A M A, vol lxxxvi, pp 293-294, July 28, 1923
- ⁶ Aldrich, C A, and McClure, W B Intradermal Salt Solution Test Its Prognostic Value to Nephritis with Generalized Œdema J A M A, vol lxxxvii, pp 1425-1428, May, 1924
- ⁷ Lash, A F Intradermal Salt Solution Test in Normal and Toxæmic Pregnancies Surg, Gyn and Obstet, vol xliii, p 40, July, 1926
- ⁸ Baker, W J Intradermal Salt Solution Test in Scarlet Fever and Diphtheria Patients J A M A, vol lxxxviii, pp 1566-1567, November, 1924
- ⁹ Harrison, J Intradermal Salt Solution Test in Lobar Pneumonia in Children J A M A, vol lxxxiv, p 1258, April 25, 1925
- ¹⁰ Thompson, W O Jour of Clin Investigation vol ii, No 6
- ¹¹ Cohen, M B The Intracutaneous Salt Solution Test Preliminary Report of a Simple Method for Determining the Efficiency of the Circulation in the Extremities J A M A, vol lxxxiv, pp 1561-1562, May 23, 1925
- ¹² Cohen, M B, Applebaum, H S, and Hainsworth, E L The Intracutaneous Salt Solution Test J A M A, vol lxxxvi, p 1677, May 29, 1926
- ¹³ Stern, W G, and Cohen, M B The Intracutaneous Salt Solution Wheal Test J A M A, vol lxxxviii, p 1355, October 23, 1926

CHRONIC STRAIN OF THE LUMBAR SPINE AND SACRO-ILIAC JOINTS¹

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EVERY diagnostician is familiar with the fact that systematic palpation of abdomens reveals deep-seated midline tenderness in a fairly high percentage of cases. This tenderness is usually ascribed to "aortic tenderness," to hyper-sensitive sympathetic nerves or ganglia or to the dragging of ptosed viscera. None of these theories seems to explain the clinical pictures satisfactorily.

On careful examination of these cases it will be found that the tenderness is sharply limited to the area of the intra-abdominal vertebral bodies and that all aspects of the vertebral bodies (and intervertebral discs) that are accessible to palpation are uniformly tender. The great majority of the patients who exhibit marked midline tenderness also have an isolated area of tenderness in each iliac fossa.

That the midline tenderness might be due to "aortic tenderness" is suggested by the fact that the patient does not experience any discomfort when the examiner places his finger tips on the midline above the umbilicus and exerts barely enough pressure to feel the pulsation of the aorta, but when the examiner then firmly presses his finger tips only a fraction of an inch deeper, the patient will writhe out from under his fingers because of the pain which is produced. That the tenderness is not limited to the aorta, however, is easily demonstrated by the examiner finding that his finger tips (with palm facing the spine), pressed deeply over the outer edge of either rectus muscle into the corresponding paravertebral gutter, do not cause any discomfort, but that when he "hooks" his fingers inward, toward the midline, the patient will manifest distress as soon as and wherever the fingers encounter the resistance of the lateral surfaces of the vertebrae.

The ramifications of the sympathetic nervous system are so very widespread within the abdomen (Fig 1) that it is inconceivable that any purely sympathetic lesion could be so consistently and sharply localized to the area represented by the vertebral bodies. Furthermore, it is improbable that the sympathetic system is endowed with sensory fibres or terminals that would manifest a sensation of pain on pressure stimuli.

Because of midline tenderness being found so commonly in patients with visceroptosis has led to a rather general acceptance of the theory that it is caused by the ptosed viscera dragging on their attachments to the posterior parietes. But this theory likewise seems untenable, because of the utter improbability of ptosed viscera being able to exert a sufficiently concentrated drag to produce tenderness over every palpable part of the vertebral bodies.

¹ Read before the Philadelphia Academy of Surgery, December 6, 1926

and yet not produce any tenderness away from the spine itself. Except for the possible factor of intestinal stasis, it is improbable that ptosed viscera



FIG. 1 —The intra-abdominal sympathetic nervous system

(From Broesike's Anatomy)

exert any more pull than do viscera in normal position. Any increased weight of viscera due to intestinal stasis mainly affects the colon, and especially the

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cæcum, and should be manifested chiefly at the site of attachment of the definitive mesocolon. It would therefore seem that any tenderness induced by pull on the definitive ascending or descending mesocolon should be located lateral to the spine and not along a considerable length of the intra-abdominal spine itself.

I am inclined to the belief that chronic midline tenderness is usually due to chronic sprain of the vertebral joints, although it may occasionally result from localized or diffuse

arthritis. The great majority of patients who exhibit midline intra-abdominal tenderness are of the asthenic type and have visceroptosis and exaggerated lumbar lordosis. Any increase in the forward curvature of the lumbar spine tends to widen the anterior aspect of the intervertebral spaces. (Figs 2, 5 and 8.) The more marked the lordosis the greater is the strain on the periarticular structures. This increased postural stress cannot be adequately met by the atonic skeletal musculature, and the ligaments or their periosteal attachments surrounding the front and sides of the

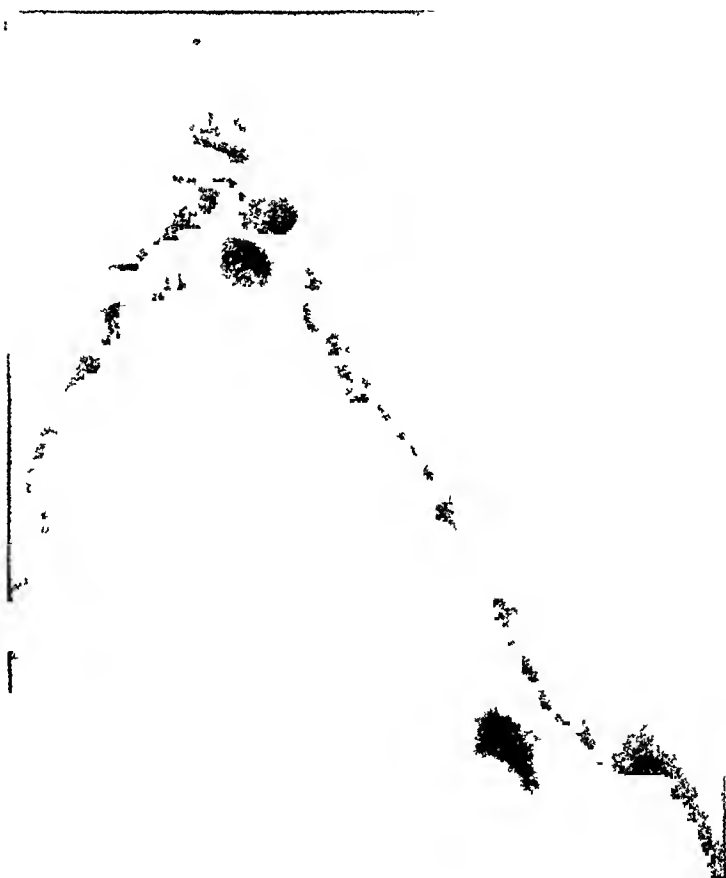


FIG. 2.—Excessive lumbar lordosis. Note V-shaped widening of intervertebral spaces. Intra-abdominal vertebral and sacro-iliac tenderness. Incapacitated as school teacher for seven years by abdominal pain and tenderness. Had futile appendectomy and cholecystectomy. Relieved by corset and novocaine injection of intercostal nerves.

vertebral bodies as far down as the top of the sacrum are therefore continuously subjected to undue strain resulting in chronic tenderness.

The condition is quite analogous to the strain and tenderness which accompany the breaking down of the arches of the feet. It occasionally happens, that tenderness and evidence of ligamentous strains may be encountered in feet that have unusually high arches at the beginning of their breaking down process. Similarly I believe that exceptionally a fairly normal lumbar curve which is tending toward increased lordosis will exhibit the tenderness of undue ligamentous strain, even before a physical examination or a lateral skiagram of the spine, will demonstrate any undue lumbar lordosis. On the other hand, completely flat feet and excessively lordotic spines may be free from tenderness. It is therefore evident that the degree

of lumbar lordosis is not necessarily the true index as to the amount of tenderness

Midline tenderness is most easily demonstrable a couple of inches above the umbilicus where the convexity of the lumbar lordosis most nearly approaches the anterior parietal wall. Slightly above this point it is not possible to depress the muscles in the intercostal angle sufficiently to palpate

the more deeply situated vertebrae. The tenderness extends down to, and includes, the sacrolumbar joint, but does not extend more deeply over the brim of the pelvis.

It is interesting to note how little deviation from the routine method of palpating the appendix is necessary to evoke spinal tenderness. On making deep rotary palpation over McBurney's point with flat fingers, the examiner needs to exert only a little push toward the midline in order to elicit tenderness, which, if he is not aware of having touched the sensitive lumbar vertebrae with the tips of his fingers, he is very apt

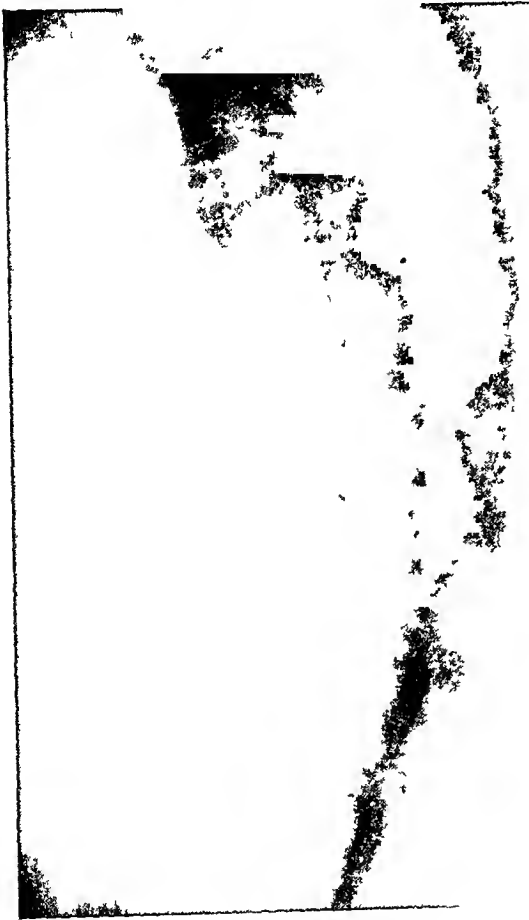


FIG. 3 —Round shoulders compensatory to the lumbar lordosis of Fig. 2

to mistake for tenderness under the pulps of his fingers and therefore erroneously regard it as appendix tenderness.

Although patients describe their spinal tenderness in diverse terms, yet the tenderness appears to be of a special characteristic type, because I have frequently made contrasts between it and other co-existent and diverse forms of visceral or parietal tenderness, and intelligent patients have always been able to distinguish the spinal tenderness from other types of tenderness. I emphasize the characteristic nature of this tenderness because it is of exactly the same nature as tenderness which can be elicited over an isolated linear area in each iliac fossa, in almost every case of vertebral tenderness. The situation of these linear areas of tenderness correspond exactly to the position of the superior sacro-iliac joint line. In discussing the anatomy of the sacro-

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iliac joint with clinicians, I find that all of them are familiar with the fact that this joint presents one aspect posteriorly in the buttock region and a second aspect anteriorly within the true pelvis, but that very few of them are aware of the third or superior aspect located in the iliac fossa (Fig 9) The anterior ligaments, joining together this third or superior aspect of the sacro-iliac joint, are subjected to undue strain in cases of excessive lumbar lordosis, and they exhibit tenderness of the same character as anterior vertebral ligaments

Tenderness of the superior sacro-iliac joint is located in a line parallel with and about one inch away from the lumbar vertebrae and extends from about the level of the anterior iliac spine upward for a distance of two inches In patients having a very thin relaxed abdominal wall, as in feeble multipara, it is possible to palpate the depths of each iliac fossa both to the outer side of the superior sacro-iliac joint line, and between the joint line and the vertebrae without finding undue tenderness even when the joint line and the lumbar vertebrae are very sensitive In patients with thick or tense abdominal walls, it is not



FIG 4 —Hollow back and round shoulders Same as Figs 2 and 3

possible to demonstrate the absence of hyperæsthesia between the sacro-iliac joint and the lumbar vertebrae

A pin passed at right angles through the anterior abdominal wall of the cadaver at McBurney's point will strike the superior sacro-iliac joint line or within one-quarter inch of it It is therefore obvious that the linear tenderness of a sensitive right sacro-iliac joint in part lies directly beneath McBurney's point and in part corresponds very closely to the tender point which Morris describes as finding by pressing deeply upon the abdomen about "an inch and a half to the right (or left) of the navel and a trifle

caudad" and which he believes is due to hypersensitiveness of the fused second and third lumbar ganglia. He believes that tenderness of this sympathetic ganglion when it is found on the right side only is the most valuable single sign of the presence of a chronic appendicitis, but when the tenderness is bilateral it points to an irritative or suppurative lesion in the pelvis. It is also interesting to note that Hunner finds deep tenderness "at a point about one inch to one side of and one inch below the navel," which he believes is

located in the ureter where it crosses the pelvic brim and is indicative of a ureteral stricture. He states that "this sign has led to countless futile appendicitis operations even when it was present over the left ureter alone." He usually finds that both ureters are tender. In passing, it is interesting to note that some of the "vague or complicated abdominal or pelvic pains" with widespread referred pains which Hunter describes in his various papers as occurring in ureteral stricture, are very similar to the pains which I find in some cases of "intercostal neuralgia." I believe the tender areas variously




FIG 5 —Lumbar lordosis with V-shaped intervertebral spaces. Sensitive lumbar vertebrae and sacro iliac joints. Anterior parietal pain and tenderness began during puerperium and persisted every day for two years when a simple supporting corset was applied. Symptoms disappeared in two weeks and had not returned after seven months.

described by Morris, Hunner and myself are probably all one and the same thing. It is also a not uncommon event for the general practitioner who discovers this deep-seated area to ascribe it to tenderness located in the appendix itself and because of the tenderness being rather acute, he sends the patient to the surgeon for a hurry-up appendectomy even though the temperature, pulse and leucocytes be normal with absence of spontaneous pain and rigidity. Fortunately this hypersensitive area is nearly always bilateral and the importance of its presence at McBurney's point on the right side is completely annulled by exactly similar findings on the left side.

Furthermore the type or quality of the tenderness over these areas corresponds very closely with the commonly associated tenderness of the vertebral bodies. In my experience this area of tenderness has assumed importance only because of the need to differentiate it from chronic or subacute appendi-

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citis In itself it is of absolutely no value as a sign for or against the presence of appendicitis It is frequently found in patients from whom the appendix has been removed Usually the patient does not have any subjective symptoms associated with this tender area He, or rather she, seeks medical advice because of some other condition and the linear tenderness is first discovered during the systematic palpation of the abdomen

Whether or not I am correct in assuming that chronic strain is responsible for the one elongated midline area and the two shorter lateral areas of tenderness, the clinical fact remains that tenderness of these three deep-seated areas habitually occurs independently of any intraperitoneal lesion Tenderness in any one of the three areas is almost invariably associated with tenderness in the other two areas

Any clinician who is not familiar with midline tenderness will find, on reviewing his method of examining abdomens, that he habitually fails to palpate over the midline I have been very much interested in observing the routine followed by various consultants in palpating an abdomen by

going down one side and up the other without touching the midline They seem to have in mind and conscientiously attempt to palpate liver and gallbladder, duodenum, right kidney, appendix, right ovary and then left ovary, sigmoid, left kidney, and spleen, but they ignore the midabdomen

Dr B P Widemann has been of great assistance in studying lumbar lordosis from a roentgenologic point of view He uses the same technic in every case The patient stands with one side against an erect Potter-Bucky



FIG 6 —Round shoulders compensating for exaggerated lumbar lordosis shown in Fig 5

diaphragm at a focal distance of thirty inches. Cotton pads are carefully adjusted to fill in the space between the Potter-Bucky diaphragm and the lateral wall of the abdomen. Immobilization of the body to the diaphragm

is obtained by encircling the body with four-inch wide linen straps at the levels of the hip-joint and of the middle of the chest. Care is exercised to prevent distortion.

The sacro-iliac joint strain is due to sacral participation in the lumbar lordosis. The lumbo-sacral joint line is widened in front and the entire bony pelvis is rotated more or less on a transverse axis, so that the pubes is tilted downward and the sacrum backward and upward (Fig 2). These changes result in an abnormal line of weight-bearing at the sacro-iliac joints.

The mechanism of weight-bearing by the lumbar vertebrae themselves is also disturbed. Normally each vertebra bears its superimposed weight on three points of support, *viz.*, the body and the two articular processes. In exaggerated lumbar lordosis that portion of the weight normally borne by the front half of the vertebral body is transferred from it to the posterior half of the same body and its two associated articular processes.

Excessive lordosis in the lumbar region is commonly associated with a

FIG 7—The round shoulders and hollow back of same case as Figs 5 and 6

variable degree of compensatory kyphosis (round shoulders) in the thoracic regions (Figs 3, 4, 6 and 7).

These various changes in the antero-posterior curvature of the spine may be present without any subjective symptoms and without trans-abdominal tenderness of the lumbar vertebrae. Usually, however, the bodies of the lumbar vertebrae are tender and the majority of the patients have backache.

In many of the patients with exaggerated lumbar lordosis the dominant symptoms are those of intercostal nerve irritation, more or less widespread but manifested mainly by pain and tenderness over the abdomen particularly in the right lower quadrant.

In a recent paper I pointed out that intercostal neuralgia of the anterior

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abdominal wall is a very common affection that frequently leads to erroneous diagnoses and to futile intra-abdominal, pelvic and genito-urinary operations. I will not repeat here an original test and various clinical examinations which I described in that paper to differentiate intra-abdominal lesions from neuralgic pain and tenderness of the anterior abdominal wall.

I am convinced that exaggerated lumbar lordosis is a common cause of neuralgia of intercostal and first lumbar nerves, but I have been unable to demonstrate the mechanism by which it is produced.

It is possible that increased weight-bearing at a disadvantageous angle leads to irritation of the joints formed by the articular processes and probably also of the posterior part of the joints between adjacent vertebral bodies. Any peri-articular exudate resulting from irritation or chronic inflammation of these joints would be deposited in the immediate vicinity of the spinal nerves as they make their exit from the intervertebral foramina. This explanation may prove true in some cases but in many others the abrupt changes in severity of symptoms, the relief afforded by rest, and the absence of rigidity of paraspinal muscles indicate some other mechanism.

In making its exit from an intervertebral foramen each intercostal and lumbar nerve passes at a right angle across the edge of a ligamentum subflavum. It is quite conceivable that the instability of a lordotic spine results in excessive intervertebral movements with undue friction between each nerve and its adjacent ligament.

Although numerous nerves may be involved, the twelfth intercostal and first lumbar are usually the ones most affected, causing pain and tenderness in the lower abdomen suggestive of appendicitis or tubal disease.

In the treatment of my cases of chronic strain of the lumbar vertebrae I have had hearty cooperation from my orthopaedic friend, Dr. DeForest



FIG. 8.—School boy age twelve years. Intra-abdominal vertebral and sacro-iliac tenderness. Repeated attacks of anterior parietal pain and tenderness erroneously diagnosed 'recurrent appendicitis'.

Willard The milder cases of lumbar lordosis may go through life untreated without symptoms

The ideal treatment is prevention or early correction of beginning excess lordosis I have had several children referred with a diagnosis of chronic or recurrent appendicitis in whom all the symptoms were due to excessive lumbar lordosis (Fig 8) and intercostal neuralgia Several of this group have recently begun taking corrective muscular exercises under Doctor Willard's supervision It is too early to note improvement in them but Doctor

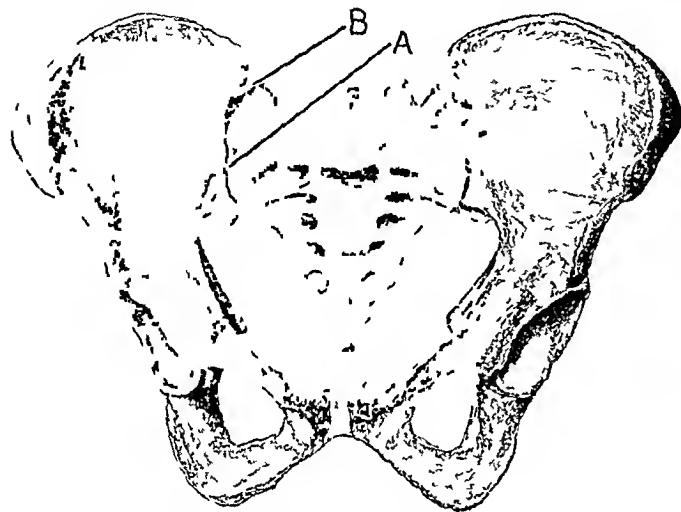


FIG 9 —Female pelvis A to B is the superior sacroiliac joint line located in the iliac fossa (Modified from Piersol)

Willard states that he has had excellent results in similar cases Correction of the hollow back in children may favorably influence, but is not likely to overcome the coexistent visceroptosis

Patients who first appear during a hyperacute stage of intercostal neuralgia may have to be treated by rest in bed, by removal of toxic foci and by sedatives pending partial

subsidence of pain and tenderness Patients in the subacute stage require a spinal support to relieve the strain on the lumbar vertebrae This purpose is best accomplished by a corset with firm stays extending from the sacrum upward over the short ribs posteriorly and with a pad over the lower abdomen I believe that the relief of subjective symptoms obtained by the use of pads and belts in visceroptosis is usually due to relieving strain on the lumbar spine rather than to any elevation of viscera Corset pressure must be gentle at first, otherwise it will not be tolerated, because of the neuralgic tenderness of the anterior abdominal wall Relief of subjective symptoms of backache and neuralgia may be attained without any noteworthy change in the lumbar curve

Even when the upper intercostal nerves are irritated long corsets are not indicated Correction of the lumbar strain automatically relieves the stress in the dorsal region Subjective symptoms are relieved promptly and completely in some cases, but are very refractory in many others In obstinate cases baking and massage of the back are helpful The milder chronic cases and the acute cases after subsidence of acute symptoms should take systematic exercises directed primarily to strengthening the abdominal muscles and they should endeavor to hold their spines in the corrected position

FRACTURES OF THE TRANSVERSE PROCESSES OF THE LUMBAR VERTEBRÆ*

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FROM THE SURGICAL CLINIC OF THE BECKMAN STREET HOSPITAL

THERE is apparently considerable difference of opinion in regard to the frequency, importance and method of treatment of fractures of the transverse processes of the lumbar vertebrae. From the scarcity of references in the literature one would think the lesion either rare or of little moment. Some even suggest that it is non-existent, the X-ray appearance being due to bony abnormality. Lumbar pain is often obscure and this may be one factor in it. The recognition of this lesion may rule out more serious conditions, *e.g.*, tuberculosis of the spine, chronic arthritis, and affections of the lumbo-sacral region. A knowledge of the amount of disability caused is important for one thing in estimating insurance loss, as many of these are compensation cases. Some state that prolonged immobilization or more radical procedure is necessary, apparently feeling that they are dealing with an injury followed by considerable disability. In this paper I wish briefly to review the literature and our experience in ten cases at the Surgical Clinic of the Beckman Street Hospital.

Frequency—Ehrlich,¹ in March, 1908, reported what he considered the first case of isolated fracture of a transverse process of a lumbar vertebra to be discovered by X-ray.

Later in the same year, Haglund² reported seven cases of isolated fractures of the lumbar transverse processes occurring in his own practice during the previous six years, all verified by radiographic examination. He refers to six similar cases, not, however, verified by X-ray.

Lange³ added two cases in 1908, one from strain and one from direct violence, and stated that in each case the injury might well have been passed over as a simple strained back. He believed that the pain might persist for a considerable period because of non-union or delayed union, or that the patient through postural changes might acquire persistent scoliosis.

I could find no further reference to this condition in the literature until 1916, when Cotton⁴ reported twenty-two cases so listed in their X-ray department. In ten of these he could see nothing which he personally would call a fracture. He believed that one must consider separate ossification centres and old ununited fractures. Six of the remaining twelve cases, he believed to represent irregular ossification or lumbar ribs. Three others he felt might be due to old injuries. In the remaining three which were recent injuries by direct violence, he concurred in the diagnosis of fracture.

* Read before the Section of Surgery of the New York Academy of Medicine, January 7, 1927.

Breiman⁷ emphasizes the fact that the transverse processes of the lumbar vertebrae, especially the first, frequently show anomalous development. He found this in 5 to 10 per cent of a series of gastro-intestinal patients examined by X-ray.

In a discussion of 134 back injuries in industrial accidents, Sever⁷ mentions only one with fracture of the transverse process. This occurred as a

result of a direct blow from a falling object, causing fracture of four processes in the lumbar region.

Stimson⁸ states that "fracture of the transverse or articular processes occurs in combination with other fractures (of the vertebrae) in about one-sixth of all cases, but is rare except in such combination. In the few instances in which it has occurred alone, it was the result of a gunshot injury."

The lesion is not mentioned in such volumes as Scudder's *Treatment of Fractures* or Jones' *Orthopaedic Surgery of Injuries*. Among 2200 admissions

FIG 1—Case I. Fracture of the transverse processes of the 3rd, 4th and 5th lumbar vertebrae, left side.

to Beckman Street Hospital in a period of one and one-half years, it occurred ten times, an incidence of one-half of one per cent. These were all definite fractures. In three of them there were associated fractures of the bodies of the vertebrae. The series included nine males and one female. The ages ranged from nineteen to fifty-five, and four of the patients were twenty-five or under, before which age there may be incomplete fusion of the ossification centres.

Etiology—This lesion may occur from direct violence or muscular strain.

Haglund reported three cases by direct violence and three from muscular strain. Two of the latter occurred while riding bicycles and one while lifting a weight. Of Lange's cases, one was by direct and the other by indirect violence. In the latter case, while lifting the patient stated that he felt

"something give way in the small of his back" Cotton's three cases were by direct violence

In the present series all were apparently from direct violence, although in some it would be difficult to prove that muscular strain had not played an important part. Two patients were struck across the back by a falling beam, five had falls from a height striking on the back, and three were struck or run over by vehicles

Anatomy—The lumbar transverse processes, according to Cunningham,⁹ may be regarded as a series of levers to which muscles are attached. Anteriorly, lie the psoas major and the quadratus lumborum, posteriorly, the sacro-spinalis (erector spinæ O.T.). Between these are layers of the lumbar fascia, which blend at the lateral borders of the muscles and give partial origin to the obliquus internus and transversus abdominis muscles. Between the transverse processes are the vertical fibres of the ligamenta intertransversaria. "At puberty a single epiphyseal centre on each side appears at the extremity of the transverse process. Fusion of these centres is not complete until the twenty-fifth year."

Pathology—The amount of displacement of the fragments is variable. In my opinion, the fractures are accompanied by tearing of muscles and ligaments with hemorrhage.

Symptoms and Physical Signs—Severe pain and tenderness were present in the lumbar region in all these patients, but not so localized as to indicate the process fractured. Most of these patients were perfectly comfortable while lying flat in bed, but suffered pain on attempting to turn over or to sit up. In no patient was there any suggestion of root pain as if a nerve were involved. Aside from the patients, in whom there were associated spinal cord injuries, at the time of admission to the hospital, all but one could stand. Resistance of the lumbar musculature, particularly of the sacro-spinalis muscle, was present in all patients. In two, neither of whom presented other evidence of intraperitoneal injury, there was abdominal rigidity for forty-eight hours. This may have been due to injury to the attachments of the lumbar fascia, from which the internal oblique and transversalis muscles arise, or to a hæmatoma in close proximity to the peritoneum. Swelling of the soft parts was mentioned in seven patients, usually marked, and in several was limited to the side on which the radiograph showed the fracture. Ecchymosis of the lumbar region was observed in one patient at the time of admission and two others showed a distinct hæmatoma, one of which was later aspirated. In all cases, the normal back movements were restricted because of pain. There was no deformity except from the swelling of soft parts. Five patients showed contusions or abrasions of other parts of the body and one had a fractured rib.

Diagnosis—The diagnosis can be definitely made only by radiograph. In these ten patients, there were thirty-two transverse processes fractured, seventeen on the right side and fifteen on the left side. Two patients had a fracture of one process only, four had three processes fractured, two had

four and two had five. In eight patients all the fractures were on the same side of the spine, while in the other two, there were three fractures on one side and two on the opposite. In both these latter patients there was also a fracture of the body of a vertebra. In three patients the left side alone was involved and in five the right. The first, second, and third lumbar vertebrae each showed fracture of the transverse process eight times, the fourth six

times and the fifth twice.

Prognosis—The length of disability in these cases is particularly important because the majority of them occur in the class of people covered by compensation insurance. Cotton thinks that this fracture is often overvalued in legal settlement. He states that, "no case has yet come to my attention with apparent fracture of the transverse processes (who did not have a claim on anyone) in whom this fracture seemed to cause disability, beyond that ordinarily associated with contusion or sprain of the back." "There does not seem to be any



FIG 2—Case VII. Fracture of the transverse processes of the 3rd, 4th and 5th lumbar vertebrae, left side, hypertrophic arthritis in lumbar region.

data on which to base any idea of any permanent disability from this cause."

Sever, in discussing injuries to the back in industrial accidents, states that "there is a peculiar mental state, analogous to that so often seen in people suffering from litigation neurosis, to be observed in many of these cases, which in my opinion delays their recovery." He found the average disability in thirty-seven cases of contusion of the back to be 6.3 months.

I feel strongly that the duration of disability in these cases may be materially reduced if the patient is not allowed to appreciate that any fracture is present. We are careful not to discuss these cases before the patient and to pronounce them bruises or sprains in talking of his injury with him. In fact, I believe it is the tearing of muscle and ligament with extravasation of blood and the resulting scar tissue, which causes the symptoms and disability rather than the existence of the fracture.

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In forecasting the future, one must also take into account previous conditions of the spine, such as structural anomalies or pathologic changes which make the spine less resistant to injury or slower in repair. The patient may have thought himself well previous to the injury, and yet suffer prolonged disability from insult to a previously existing inflammatory process, *e g*, chronic hypertrophic arthritis. While the radiograph may show recent fracture of transverse processes, the patient may make no complaint of this injury. We have had such a patient in our wards since this series was compiled. Following a fall from a height a man fractured both os calcis and the transverse processes of the first and second lumbar vertebrae. After the usual rest in bed, on sitting up he complained of pain in the back, out of all proportion to what we have usually seen in these cases. Examination showed all his pain and tenderness to be in the lower, rather than the upper, lumbar region. In going over the radiographs, we found an extensive hypertrophic arthritis with spur formation in the lower lumbar region. He claimed that, although he performed heavy labor, he had never had any discomfort in the back until the present injury. I believe his condition was due to an acute exacerbation of the arthritis following injury, rather than to the fractures. When seen five months after his injury, he had no symptoms nor limitation of motion referable to the back.

This brings up an important point from the industrial and economic view. Many corporations now require a physical examination before employment. The discovery of the presence of a hernia in this examination is said to have been a great saving in after claims. How much more important would be a careful back examination of those who are to be engaged in heavy labor, together with a history of any previous complaints referable to this region. Back injuries are common, malingering is probably quite rare, but many men undoubtedly get credit for it when a mild accident upsets a compensated structural difficulty or activates quiescent disease or injury and thereby initiates disability. Routine radiographs of the spine before employing men over forty at hard labor is more than we can expect to obtain, but I believe would be a distinct economic saving to the employer.

Except for the two cases with accompanying spinal cord injury, the hospital stay for these patients ranged from two to thirty-two days, with an average duration of sixteen days. That is, they were able to walk about in this time, though not to return to their usual work.

In regard to the healing of the fracture, Cotton states that it "may not improbably unite by fibrous union without persistent symptoms."

Osgood⁹ states that "fractures of the transverse processes recover if immobilized, but often remain ununited and painful if not recognized and not treated."

In Case VIII, a radiograph taken twelve weeks after injury showed distinct bony union of the third transverse process and suggestive bony union in the first and second, while one taken six months after injury showed

apparently solid union of all fractures. Another case, not considered in this series, shows bony union eight months after injury.

Treatment—The treatment advised has been varied. Lange states that in his cases, rest in bed, strapping, salicylates, and potassium iodide failed to help, but that the galvanic current gave some temporary relief. Cotton's

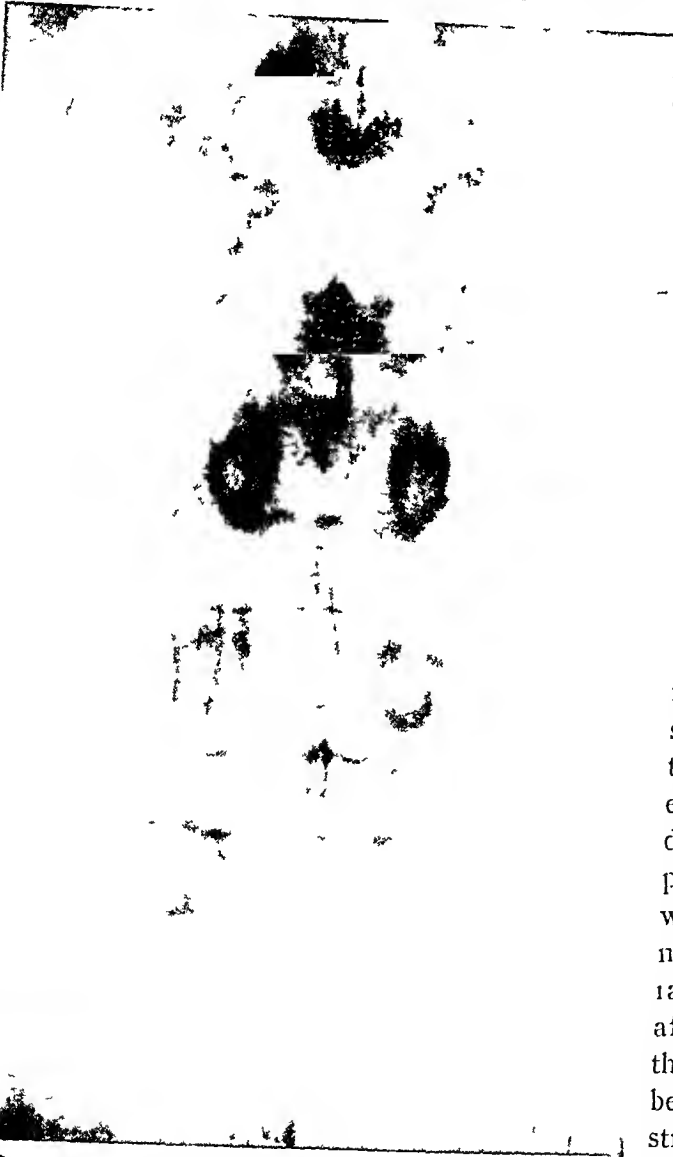


FIG 53—Case X. Fracture of the transverse processes of the 1st, 2nd and 4th lumbar vertebrae, right side.

three cases were all put up in plaster jackets, but the duration of this immobilization is not stated. Osgood suggests complete immobilization for six weeks. Physiotherapy in the form of heat and massage is our routine treatment, commencing usually as soon as the diagnosis is made. The static machine is substituted for manual massage when the patient is allowed out of bed. All patients were put to bed immediately on admission and in most of them the pain was severe enough to require one dose of morphine. Three patients were strapped with adhesive plaster immediately after being radiographed. A fourth, after being in bed for three weeks, was strapped before getting up and the strapping left on for two weeks. Both longitudinal and transverse strapping

were employed. In other words, these patients were treated in the same way that we would treat a simple contusion or sprain of the back. With a patient in bed, I believe pain will act more efficiently to immobilize the ordinary injured back than any artificial means we ordinarily use.

CASE REPORTS

CASE I—A F, male, age sixteen, occupation, clerk. Admitted to hospital, December 14, 1924, having been knocked down by an automobile. Physical examination showed tenderness over the lumbar region, most marked at the level of the second lumbar vertebra.

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There was slight swelling over the same region "Unable to stand" X-ray Fracture of transverse processes, lumbar 3, 4, 5, left Treatment Back strapped Fifteen days later he was discharged to the out-patient department with little complaint of back He failed to return and could not be traced

CASE II—H A, male, age twenty-five, occupation, elevator helper Admitted to hospital, August 14, 1925, having fallen six stories in an elevator shaft striking on back Physical examination showed contusion over lower lumbar region and entire loss of motive power and sensation of both legs X-ray Fracture of transverse processes, lumbar 1, 2, 3, 4, left Backward dislocation of twelfth dorsal vertebra Operation Laminectomy Died of lobar pneumonia thirty-three days after injury

CASE III—H R, male, age forty, occupation, iceman Admitted to hospital, September 16, 1925, having fallen to the ground from his wagon, striking on his back Physical examination showed pain in the right side and restricted breathing X-ray Fracture of tenth rib right in posterior axillary line and of tip of transverse process of lumbar 1, right Treatment Chest strapped The patient showed few symptoms referable to the back and was discharged to the out-patient department after two days, but failed to return

CASE IV—H M, female, age thirty-two, occupation, elevator operator Admitted to hospital, August 11, 1925, having fallen one flight in an elevator shaft striking on her back Pain in lumbar region was severe Physical examination showed marked tenderness over the lumbar region with swelling and ecchymosis on the right side X-ray Fracture of transverse process of lumbar 1, right, with arthritis of the spine and sacroiliac joints After two and one-half weeks, patient had slight discomfort in right hip region on weight bearing There was no tenderness in the lumbar region at the site of the fracture After two months the patient was having only occasional mild discomfort

CASE V—E G, male, age fifty-five, occupation, laborer Admitted to hospital, October 27, 1925 shortly after a fall of fourteen feet striking his back on a beam Physical examination showed both legs flaccid with loss of sensation X-ray Fracture of transverse processes of lumbar 1 and 2, right, and lumbar 1, 2 and 3, left, fracture of body of first lumbar with dislocation, fracture of articular process of twelfth dorsal and fourth lumbar Treated on Bradford frame After one year the paralyzed condition was practically the same

CASE VI—S R, male, age forty-six, occupation, truckman Admitted to hospital December 3, 1925, having been caught between two trucks Physical examination showed considerable ecchymosis over both lumbar regions, more marked on the right X-ray Fracture of transverse processes of lumbar 2 and 3 left and lumbar 2, 3 and 4 right No displacement of fragments Compression fracture of body of fourth lumbar vertebra Treatment hæmatoma aspirated Discharged against advice after two weeks Advised to remain in bed at home for ten days more and then use a supporting corset Two months after injury he was coming to hospital regularly for physiotherapy and improving steadily

CASE VII—J W, male, age fifty-four, occupation, longshoreman Admitted to hospital, January 7, 1926, having had a beam fall partially across his back Patient complained of extreme pain in back immediately Physical examination showed tenderness and swelling over whole lumbar region X-ray Fracture of transverse processes, lumbar 3, 4 and 5, left, marked hypertrophic arthritis in lumbar region, lack of union of transverse process of lumbar 1 Course After three weeks patient had no complaints referable to back and was allowed out of bed, at which time his back was strapped This was left on for two weeks He was last seen eight months after the injury when he did not complain of his back He complained throughout of his right shoulder, although the X-ray and examination were negative

CASE VIII—O S, male, age thirty occupation, laborer Admitted to hospital, May 13 1926, having been struck on the back by a falling beam Physical examination showed marked tenderness over whole abdomen and lower back with moderate swelling over lumbar region There was abdominal rigidity for the first forty-eight hours X-ray

Fracture of transverse processes of lumbar 1 2 and 3, right Course After three weeks the patient was still complaining of pain and tenderness in the back, but when he did not know he was being watched, was seen to walk and bend without apparent discomfort He was discharged from the hospital after three weeks with the function of his spine limited to 50 per cent After three months his disability was estimated as 12½ per cent Six months after the injury, he was running a machine in a factory, where he could sit all the time X-ray, at this time, showed union of all his fractures

CASE IX—M R, male, age nineteen, occupation, glazier Admitted to hospital,



FIG 4—E K treated since this series was compiled Fracture of the transverse processes of the 1st 2nd 3rd and 4th lumbar vertebrae right side Symptomless and at usual work six weeks after injury

May 13, 1926, having fallen three stories in elevator shaft striking lower back The pain in the lumbar region was severe Physical examination showed a larger hæmatoma over the lumbar region more marked on the right side Abdominal rigidity was present for forty-eight hours There was macroscopic blood in the urine on admission and microscopic blood persisted for one week X-ray Fracture of transverse processes of lumbar 1, 2, 3 and 4, right After one week the patient was walking without pain After one month he had no complaints except some pain radiating down right thigh and leg

CASE X—B R, male, aged twenty-four, occupation, laborer Admitted to hospital, May 18, 1926 a fire reel having run over his back Claimed he could not stand and had severe pain on any movement for several days Physical examination showed a marked hæmatoma with

rigidity of the muscles in the lumbar region X-ray Fracture of the transverse processes of lumbar 1, 2 and 4, right Course Strapped for eight days Sitting up in bed after one week Walking in twelve days, but back painful on bending After six weeks movements in all directions were complete without discomfort When seen five months after the injury, this was still true The patient, who had been doing light work from two months on, was then advised that he could take up any occupation he wished

Results—Cases II and V are not considered in the results as each had a fracture dislocation of the body of a vertebra The patient in Case III was discharged to the dispensary two days after injury with no treatment except chest strapping for a fractured rib It has been impossible to trace him The patient in Case I was discharged to the dispensary after fifteen days with

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a note that there were few symptoms referable to the back. He, likewise, did not return and could not be traced. The patient in Case IV received physiotherapy for two months and after that time, claimed to have only occasional mild discomfort. The patient in Case VI after two months was reported as improving steadily under physiotherapy. The patient in Case VII had no complaints referable to back at the end of three weeks and after a month, records showed normal motion of the trunk on the pelvis, except for some limitation of extension. After seven weeks, however, extension was also said to be complete and without discomfort. He was last seen eight months after the accident, when he was working and did not complain of his back.

The patient in Case VIII was discharged from the ward after four weeks with pain still present and an estimated back function of 50 per cent. After three months his disability was estimated as $12\frac{1}{2}$ per cent. The entire back was held in extreme rigidity, a great deal of which appeared to be voluntary rather than protective. The radiograph at this time showed marked scoliosis toward the affected side, with apparently bony union of one transverse process and suggestive of bony union of the other two. After six months the patient still complained of pain and showed tenderness and spasm of the sacrospinalis muscles, more marked on the side opposite to the fracture. His previous occupation had been that of laborer with the pick and shovel, but he was then working at a machine where he sat all day. The radiograph showed apparent bony union of all three processes. That is, this patient continued to have pain and disability although the fractures were united.

The patient in Case IX, at the end of four weeks, complained only of some pain radiating down the right thigh and leg. The patient in Case X had no complaints after six weeks and movements in all directions seemed to be complete without discomfort. Settlement of his compensation was made two months after injury and he returned to light work immediately. I saw him after five months, when movement was complete in all directions without discomfort and he was advised to do any work he saw fit. That is, in this series but one patient continued to show marked disability after six months and in his case the fractures had apparently united.

SUMMARY

From these ten cases the following conclusions are suggested:

1. Among injuries to the back, fractures of the transverse processes of the lumbar vertebræ are not rare, although it is to be emphasized that bony anomalies in this region are frequent, and may tend to confuse the diagnosis.
2. The most common cause of fracture of the transverse processes is direct violence. The symptoms and physical signs are those of a severe sprain or contusion of the back.
3. Such fractures are usually multiple. When uncomplicated by body fracture, all the fractures are usually on the same side.
4. The disability caused by the injury is due solely to the associated

contusion or sprain of the back, and the presence of the fracture is negligible as far as prolongation of disability is concerned. Owing to the frequency of traumatic neurosis, it is preferable that knowledge of an existing fracture be kept from the patient.

5 Bony union of the fractured transverse processes is definite in some of these cases.

6 More careful examination of backs should be made before employing men over forty at hard labor.

7 The treatment required is rest in bed, heat and massage. Prolonged immobilization is no more necessary than in any contusion or sprain of the back.

8 In this series patients were able to walk after an average period of sixteen days. Disability over six months is out of the ordinary. The majority should be at work within two months with practically no complaints referable to the injury.

BIBLIOGRAPHY

- ¹ Ehrlich. Deutsche Zeitschrift für Chirurgie, 1908, vol xcii, p 413
- ² Haglund. Deutsche Zeitschrift für Chirurgie, 1908, vol xcvi, p 321
- ³ Lange, S. N. Y. Med Jour, October 9, 1909, pp 691, 692
- ⁴ Cotton, F. J. Interstate Med Jour, 1916, vol xxi, pp 138-142
- ⁵ Bierman, M. I. Amer Jour Roentgenology, June, 1923, vol x, No 6, pp 456-458
- ⁶ Osgood, R. B. Jour Industrial Hygiene, July, 1919, vol i, p 150
- ⁷ Sever. Jour Orthop Surg, November, 1919, vol i, No 11, New Ser, pp 657-665
- ⁸ Stimson, L. A. A Practical Treatise on Fractures and Dislocations, 6th Ed, p 150
- ⁹ Cunningham's Text-book of Anatomy, 4th Ed, var

THE USE OF THE RUSSELL APPARATUS IN THE TREATMENT OF FRACTURES OF THE SHAFT OF THE FEMUR

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IN 1924, Doctor Russell, of Melbourne, Australia,¹ published a method of treating fractures of the femur which attracted our attention by its apparent simplicity and the good results claimed for it

For some years we had been following the usual teaching and used the Whitman abduction case for fractures of the neck and base of the neck, extension with ice tongs for the shaft, especially for the supracondyloid fracture and frequent open fixation with plates for shaft fractures. Simple Buck's extension was used in fractures of the neck if the position was good. We were not particularly satisfied with the results of ice tong traction, with suspension, in fractures of the shaft and preferred open reduction with plating, although we realized that in the comminuted supracondyloid fracture ice tongs offered the best means of obtaining traction. We were, therefore, willing to try this method of Russell's, and since December, 1924, we have treated twenty fractures of the femur. When we first began this treatment we applied plaster cases to a number of them after reduction was accomplished. In a few of these cases the reduction was accomplished by operation either because we were unable to replace the fragments or we desired a better reposition. After our open reductions we applied cases. In reviewing our twenty cases we have found details in which the treatment outlined by Doctor Russell was not entirely enforced and on this account we are reporting only eight cases which had the extension applied when the patients were admitted to the hospitals, and not removed until good healing had taken place. In one case which is now being treated we were able to correct the overlapping, but we could not get the fractured ends approximated. We therefore made a small lateral incision over the fracture, and found a large quantity of muscular tissue between the ends of the bone. This tissue was removed, the fragments placed end to end, and the patient again placed in the Russell extension. An X-ray taken one week after operation showed the fragments in perfect alignment. We expect that we will have a rapid formation of callus in this case. The following case reports show that the average hospital days was forty-eight. One case who was confined to the hospital for 300 days had carcinoma of the prostate gland, and a pathological fracture of the femur. Union occurred in his fracture but he was totally confined to bed on account of his carcinoma, and for this reason his number of hospital days has not been included in the calculation of the average.

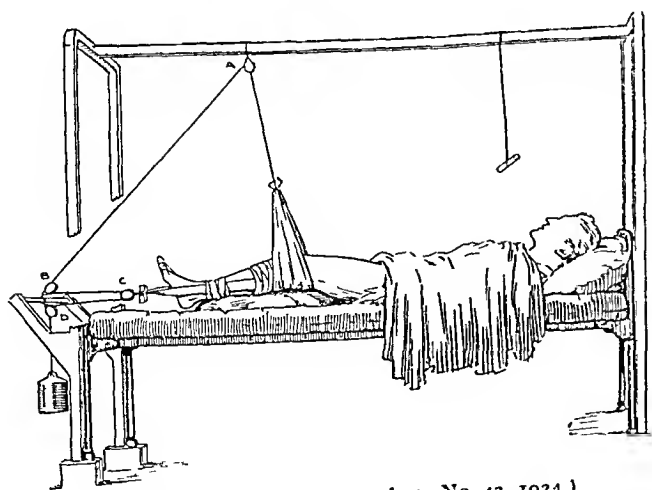
Total disability was determined by their ability to be about without the use of a cane and able to resume their usual occupation with normal function at hip, knee and ankle-joints

Case No	Name	Age	Type of fracture	Total disability	Hospital days	End result
5038	N D	10	Oblique middle third	9 Weeks	42	No shortening Normal function
2282	O C	14	Oblique upper third	8 Weeks	39	No shortening Normal function
2973	T R	55	Oblique upper third	Died carcinoma prostate	300	Good reduction and healing without shortening
549	J W	40	Oblique upper third	14 Weeks	57	15 cm shortening Slight limp Normal function in knee
1717	M F	74	Transverse middle third	10 Weeks	55	No shortening Normal function
1769	E P	54	Oblique middle third	Cannot locate	51	Good reduction and healing on discharge from hospital
2441	W R	13	Transverse middle third	9 Weeks	45	No shortening Normal function

The object of the treatment as outlined by Doctor Russell depends upon a natural and comfortable position for the limb with a comparatively small amount of extension to restore the equilibrium in the muscles of the thigh. When the muscles are extended to their normal length and if there is no interposition of tissue, the fragment ends will fall into their natural alignment.

THE APPARATUS

FIG 1



(British Journal of Surgery vol 21 No 43 1924)

(1) An overhead frame to which a pulley (A) is attached. This pulley is directly above the extremity and is so placed that a perpendicular from it will fall well down upon the leg—usually between the upper and the middle thirds.

(2) A specially constructed rigging made of wood containing two pulleys (B-D) closely associated.

(3) Buck's extension (which we apply with molskin) extending to the head of the tibia and fibula with a pulley (c) on the spreader.

(4) A sling of muslin under the knee with twine attached. The twine continues from this sling to the overhead pulley (A) to the first pulley on the rigging (B) to the

pulley on the Buck's extension (C) back to the second pulley (D) on the rigging and the weight applied. The twine is continuous and should be of small diameter with large diameter pulleys to reduce friction.

- (5) A soft pillow under the thigh and extending well down under the leg
- (6) Elevate the foot of the bed
- (7) Apply four (4) pounds weight for a child, six (6) pounds up to the age of fourteen (14) and eight (8) pounds for an adult
- (8) Do not apply too much weight
- (9) Have the heel just free of the bed
- (10) Measure the thigh daily
- (11) Examine daily for posterior bowing

Anatomy of the Thigh ^{2, 3} —The shaft of the femur is convex in front, except below the neck, where it is slightly concave. On the posterior surface is the *linea aspera*, a prominent longitudinal ridge along the middle third, which gives strength to the concavity here. Below the middle of the bone the *linea aspera* divides into the internal and external supracondylar ridges. It is composed of a head, neck, greater and lesser trochanters, shaft and internal and external condyles.

On the front of the thigh the sartorius, gracilis, and rectus femoris, which unite with the vastus internus, vastus externus and vastus medialis to form the quadriceps, arise from the pelvis and insert into the head of the tibia.

On the back of the thigh the semitendinosus and semimembranosus on the inside are seen to arise from the tuberosity of the ischium, and insert into the head of the tibia while the long head of the biceps arises from the ischium and inserts into the head of the fibula.

The above knowledge of the thigh suggests the wisdom of applying Buck's extension below the knee in order to secure the greatest amount of extension on these muscles which, as it must appear, are the greatest factors in the production of the deformities.

The Physiology of Muscles ^{4, 5, 6} —A muscle is an organ composed of many thousands of muscle fibres bound together by connective tissue and surrounded by a sheath of the same tissue.

Muscular tissue, when acted upon by a weight, extends quite readily, and when the weight is removed, it regains its original form by virtue of its elasticity. In our bodies the muscles stretched from bone to bone are in a state of elastic tension. If a muscle is severed by an incision across its belly the ends retract. A muscle that is in a state of elastic tension contracts more promptly and more effectively for a given stimulus than one which is entirely relaxed. The extensibility of muscular tissue as compared with dead elastic bodies is quite striking. With regard to the latter it is well known that the amount of strain that the object undergoes is proportional, within the limits of elasticity, to the stress put upon it, however the former acts in a very different manner, *i. e.* the greatest amount of extension occurs with the application of the first weight and decreases proportionally with new increments of weight. Haycraft calls attention to the fact that under normal conditions the physiological extension of the frog's muscles in the body is equal to that

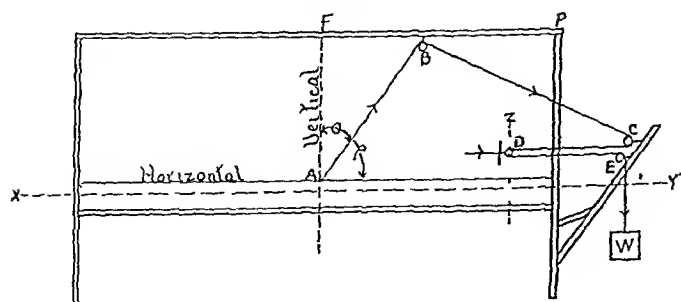
produced by a weight of ten to fifteen grams and that when the excised muscle is extended by weights below this limit, it follows the law of dead elastic bodies, giving equal extensions for equal increments of weight. It has been shown that the extensibility of a muscle is greater in the contracted than in the resting state. Under normal conditions in the body a muscle is made to contract by a stimulus received from the central nervous system through its motor nerve, however, Howell and Haller have shown that skeletal muscle possesses the properties of independent contractility and independent irritability (Bernard), the former being due to active processes developed in its own tissue and the latter the result of artificial stimulation to its own substance. Whether the nerve cell or gland cell may be made to enter into its specific form of activity by the direct application of an artificial stimulus is still undetermined, but the reactions have occurred with the motor nerves severed.

In addition to the properties of contraction and of relaxation the living muscle exhibits the phenomenon of "tone." By muscle tone is meant a state of continuous shortening or contraction which under normal conditions is slight in extent and variable. This condition is supposed to be dependent upon subminimal nerve impulses which are being continually sent into the muscles by external influences. It may be beneficial in maintaining the nutrition of the muscle, regulating the heat of the body and causing a rapid response for a sudden voluntary contraction. The sensory and motor nerves therefore play an equally important role in the production of muscle tone. Royle has shown that the sympathetic nerves which supply the voluntary muscles have control over "plastic tone," whereas the medullated nerves control the "contractile tone." Both of these properties being the result of reflected sensory stimuli and in the production of deformity in fractures are due to the effort of the patient to maintain stability of the injured limb and sensory stimuli from the irritation of the fractured ends.

Is it not essential then that the thigh should be immediately returned to a condition of muscular equilibrium by extension and a comfortable position as soon as possible after fracture occurs?

THE MECHANICS OF THE EXTENSION

FIG 2



- F = force
- W = weight
- f = friction of cord throughout system
- f = pulley friction
- $FAB = W - (f f_B f_C f_D f_E)$
- $FAC = W - (f f_B f_C f_D f_E)$
- $FAD = W - (f f_B f_C f_D f_E)$
- $FAE = W - (f f_B f_C f_D f_E)$
- $FAY = W - (f f_B f_C f_D f_E)$
- $FAX = W - (f f_B f_C f_D f_E)$

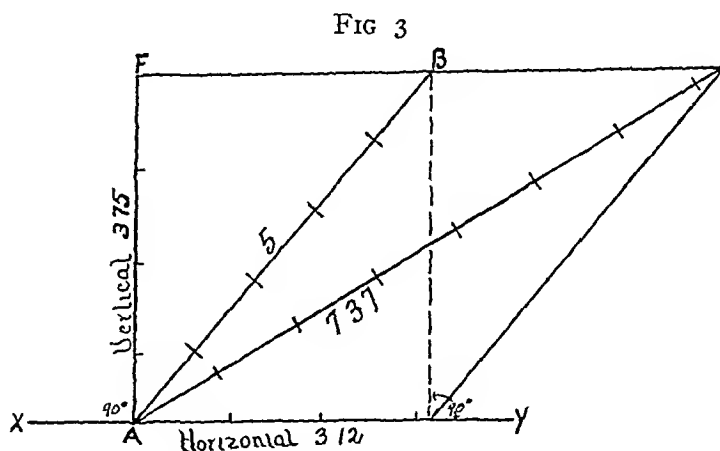
FAC and FAY may be solved graphically as shown in Fig 3

RUSSELL TREATMENT OF FEMUR FRACTURES

Explanatory—Make length of line AB in the above figure contain the same units of length as there are pounds of force along AB, the number of units in AF will give the vertical force acting at A, and the number of units of length in AY will give the horizontal force acting at A.

If it is required that FAB shall give a greater pull along AY, move pulley B nearer to P. If greater vertical pull along AF is required of FAB, move pulley B nearer F.

With the horizontal force computed a second parallelogram may be constructed and the resultant (7.37) of these two forces is seen acting in the axis of the



femur and is greater than the weight applied.

To get maximum FDC-E, the lines DC and DE must be parallel to XY and when this is so there will be no vertical forces along DZ.

To obtain maximum FAB and maximum FDC-E, the pulleys in the system must be as large as can be conveniently used.

The friction factor, f , may be considered as *practically* zero with small cord, however, f will increase with the increase in diameter of the cord used. A close-link chain would offer very little f .

The friction factor f_B f_C f_D f_E will be quite small, approximately 5 to 10 per cent of W .

The Physiology of New Bone Formation—When a fracture is produced, hemorrhage is the first and most important requisite to healing that occurs. The presence of blood about the fractured ends produces a moderate amount of inflammation and the mixture of blood clot and inflammatory exudate is formed around the fragments. The amount of this exudate determines the amount of future callus.

The blood clot becomes converted into fibrous tissue, and this tissue being acted upon by osteoblasts, which are really fibroblasts with the capacity of producing bone, is transformed into bone.

At the end of two days the intervening substance between fractured ends is granulation tissue. In the course of four or five days this becomes converted into osteoid tissue, which is tissue resembling bone in its structural arrangement with a homogeneous matrix but not possessing any lime salts. The osteoid tissue is scattered in clumps and in the intervening spaces marrow-like tissue develops. Finally lime salts are laid down and the ends are united by fully formed bone.

Part of the new bone may first be formed through cartilage. Areas of cartilage are laid down by the osteogenic tissue of the periosteum and here are invaded by new vessels, converted into osteoid tissue and finally calcified, just as happens in the normal development of bone in cartilage. This method of healing occurs where there is a large gap to be filled and where there is considerable amount of movement.

Healing of the fracture does not occur through the proliferation of the bone cells because these are end products and are incapable of multiplication

Callus is the mass of new tissue which is formed and it is divisible into three portions, namely, external, internal and intermediate. The external ensheaths the junction, the internal fills the marrow cavity and the intermediate joins the fractured ends

CONCLUSIONS

1 This method is inexpensive, practical, comfortable to the patient and simplifies nursing care

2 It is ideal in elderly patients, especially in cases of fractures at the neck when the Whitman case treatment is not desired

3 Stiffness at the knees occurs less frequently than after other methods, the period of disability is thereby reduced

4 This simple means of extension is just as efficient in the average case in effecting reduction of the fragments as is long extension with heavy weights

5 Occasionally an open operation may be required to disintegrate the fragments from binding muscle

BIBLIOGRAPHY

- ¹ Russell, R H Fracture of the Femur Brit Jour of Surg, 1924, vol vi, No 43
- ² Muller Davis Applied Anatomy, Lippincott, 1924, pp 527-528
- ³ Spalteholz Hand Atlas of Human Anatomy, Lippincott, 1923, p 349
- ⁴ Howell, William H Text-book of Physiology, W B Saunders Co, 1913 pp 20-50
- ⁵ Haycroft Jour of Phys, 1904, vol xxi, p 392
- ⁶ Royle, N D Aust Med Jour, January 26, 1924, vol vi, p 77, No 4
- ⁷ Boyd Surgical Pathology, W S Saunders, Phila, pp 84-86

HEPATITIS AND ITS RELATION TO CHOLECYSTITIS

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THE MUTTER LECTURE DELIVERED BEFORE THE PHILADELPHIA COLLEGE OF PHYSICIANS, DECEMBER 10 1926

IN SEVERAL papers written during the last nine years, Evarts Graham,^{1, 2, 3} whom I think your Committee honored the year before last as it has me this year, has presented some interesting observations and stimulating suggestions on the pathogenesis of hepatitis and cholecystitis, on the path of infection in diseases of the gall-bladder and on the association of cholecystitis and hepatitis

In reading these papers and others on the same subject, I am reminded of a saying of the hæmatologist Naegeli, quoted by Aschoff⁴ He writes "It is a sure sign of the undeveloped state of science if the logical concepts with which it deals are not fixed and when multiple meanings are assigned to the same term" I am reminded of this saying because of the confusion in my own mind regarding the exact meaning of hepatitis and cholecystitis Perhaps the disagreement and controversies that arise between clinical surgeons, pathologists and physicians, when terms such as hepatitis and cholecystitis are used, are inevitable in the uncertain state of much of our knowledge regarding these subjects and the different conceptions formed when these terms are used

At the outset it may be well to refer briefly to the observations that have been made regarding hepatitis and cholecystitis by a number of surgeons during the last ten years and to state the conclusions that have been drawn from these observations Small sections of the liver removed during operations for cholecystitis have regularly shown varying degrees of hepatitis The lesions are confined largely to the interstitial tissue where the lymphatics are situated In several instances pieces of liver removed during operations for chronic appendicitis have shown inflammatory changes Gall-bladders removed for a group of clinical symptoms which are classed as dyspepsia, and in which there was no history of gall-stone colic, have not infrequently shown very slight or no macroscopic lesions, but have shown, under the microscope, slight inflammatory infiltration of the deeper layers of the walls of the gall-bladder The conclusion has been reached that in many cases of cholecystitis there has been a direct extension to the wall of the gall-bladder from an inflamed liver, that frequently a vicious circle exists between the gall-bladder and the liver whereby each may infect the other, that the infection of the liver from an inflamed gall-bladder is an important factor in the production of cirrhosis, that lesions of the gall-bladder wall that cannot be readily recognized macroscopically give definite clinical symptoms

I may also add at the outset that anyone having the temerity to discuss hepatitis is thrown on the horns of a dilemma Either he must discuss the

subject as if hepatitis were a simple entity or he must refer to its very complex and diversified etiology and be carried into a rather loose-jointed and rambling discussion. I must beg your indulgence for the latter method.

I have thought, however, it might be of advantage to bring forward some of the problems that present themselves when the somewhat indefinite word hepatitis is used and to consider the interesting question as to when the reaction of the cells that make up the liver and the gall-bladder reaches the plane of clinical observation. In other words, what degrees of reaction in the hepatic cells or the gall-bladder wall are we justified in considering clinical entities.

There are a few features in the microscopical anatomy and physiology which seem to me pertinent to the discussion. The arrangement and relation of the blood and lymph capillaries to the liver cells are imperfectly understood. There is, however, a fairly general agreement that the portal vein and the hepatic artery spread out into the intricate capillary network which is very intimately related to the liver cells. The Danish zoologist, Krogh,⁵ who has made most extensive studies of the anatomy and physiology of the capillaries, considers that the endothelium of the hepatic capillaries is a syncytium with numerous nuclei but without defined cell borders as in the embryonal capillaries, and that the star cells of Von Kupffer, which appear at rather short, regular intervals, are an integral part of the capillary wall. The English histologist, Schafer,⁶ believes that what remains of the endothelium of the liver sinuses is represented by these stellate cells.

Blood, entering the liver through the portal vein and hepatic artery, spreads out in a large and complex capillary network, the liver cells being directly bathed by blood and not by lymph, as elsewhere in the body. Besides the polygonal liver cells and the Von Kupffer cells which make up, with the capillaries, the lobules, there is a connective-tissue stroma underneath the serous covering and between the lobules which supports the bile ducts and blood-vessels in their course through the organs. The lymphatic vessels arise from the lymph capillaries in this connective-tissue stroma. Numerous lymph vessels accompany the interlobular branches of the portal vein and numerous lymph vessels accompany the hepatic vein.

From the study of the injection specimens made by Sappey,⁷ it seems that a considerable number of fairly large lymph vessels pass along the inferior surface of the liver over the body of the gall-bladder from the adjoining quadrate lobe and the right lobe, to form an extensive anastomosing network of vessels in the neighborhood of the neck of the gall-bladder. Others, derived from the same sources, pass behind the gall-bladder to terminate in the same region. There are apparently numerous anastomosing lymph capillaries between the lymphatics of the liver and the gall-bladder.

The hepatic cells have many and diversified functions. The liver is the great laboratory and storehouse of the body. It is engaged in chemical transformations, demonstrated by the high consumption of oxygen and the production of heat. All three classes of foodstuffs—carbohydrates, fats, and

probably proteins—are built up into large non-diffusible molecules and stored in the liver cells and, by reversible ferments, again changed into soluble forms which pass out into the circulation as needed. The liver cells change the amino acids to simpler compounds, produce bile with its well-known function and play an important part in the coagulation of the blood.

But it is to a function which it shares with the reticulo-endothelial system, in rendering harmless various toxic substances and in the destruction and disposal of living microorganisms and red blood-cells, that I wish to call special attention. The stellate cells of Kupffer, which we have just said are part of the lining endothelium of the liver capillaries, belong to the group of reticulo-endothelial cells which are found in the sinuses and pulp cords of the lymph-nodes, the reticulum and the blood sinuses of the spleen and the capillaries of the bone-marrow. These cells behave in a special way in taking up dyes and other substances and show a pronounced capacity for phagocytosis.

Kupffer showed that the star cells in the liver were loaded with the pigment after the injection of india ink. These experiments have been many times confirmed. Various chemicals injected into the circulation are taken up in the same way by the stellate cells. Certain salts are not arrested, the cells show a power of selection and certain substances are taken up and stored in the liver cells. A number of careful experiments by Roger⁸ and others have shown that alkaloids are arrested in the same way in the liver. Some of the alkaloids lose a portion of their toxicity in passing through the liver, some of them are excreted in the bile and, according to Roger and others, the detoxicating effect varies with the abundance of glycogen in the liver.⁹ There can be no question of the arrest, storage and destruction in the liver of a number of simple and complex chemical substances.

The action of the liver on microbes is equally interesting. Wyssokowitsch¹⁰ showed, many years ago, that pathogenic and non-pathogenic microbes and the spores of molds were arrested and taken up by the cells of the capillaries and sinuses in the liver, bone-marrow and spleen. The capillaries and sinuses in these regions are great settling basins where all manner of minute foreign substances are deposited and taken up. Although all the cells of the so-called reticulo-endothelial system in these situations are largely concerned in the reactions, it by no means implies that their behavior in the liver, spleen and bone-marrow is the same. The stellate cells of the liver are not the exact equivalent of the endothelial cells of the splenic sinuses, for example. Bacteria are not taken up to the same extent in all the depots of this system of cells. The Kupffer cells of the liver seem to take up and retain large numbers of microbes at an early stage at least in inoculation with certain microbes and in certain animals.

Bacteria and other foreign substances taken up by the reticulo-endothelial cells in the bone-marrow and spleen are destroyed there or start to grow and invade again the blood stream. But for the material deposited and taken up by the liver cells there is another possibility. The foreign particles may be

excreted in the bile. In Wyssokowitsch's (18) experiments he expressly states that the bacteria taken up from the blood stream do not pass out by the excretions and secretions of the body. But it has been proved over and over again, during the last forty years since he made his precise and interesting observations, that bacteria injected into the portal vein or the systemic veins, if injected in sufficient dosage, regularly enter the bile. Nichols¹¹ recorded in 1916 a number of carefully carried out experiments and reviewed and criticized the work done up to that time by Futterer, Chiarolanza and Koch. He injected varying doses of typhoid bacilli and cholera vibrios into the systemic veins and into the portal vein in immune animals and in animals in which no immunity had been established. He found fairly large doses were necessary to make bacilli appear in the bile and a larger dosage was required in the systemic veins than in the branches of the portal vein. He records several instances in which the results were strikingly inconstant, the same dosage injected in a portal vein in one instance showing numerous colonies cultured from the bile and in another showing not a single colony. There were marked individual variations in elimination. Immune animals showed a greater power of excreting bacteria in the bile than non-immune animals. Rapid agglutination *in vivo*, deposition in the liver and corresponding elimination are suggested as explanations. The bacilli began to appear in the bile with astonishing rapidity, being found in two to three minutes after portal injection and the first plates showed the largest number of colonies.

The reticulo-endothelial cells are concerned not only in taking up foreign bodies and, through the action of various intracellular ferments, modifying or destroying them, but they are also concerned in furnishing and secreting various substances which aid in the destruction of microorganisms and in the neutralization of their toxins. Metchnikoff¹² wrote that it was probable that the macrophages (and in his macrophage system is found the first suggestion of a reticulo-endothelial system) represented the principal source of antitoxin. Since then it has been shown by Hahn, Von Skramlik and Huenermann¹³ that the perfusion of the liver of a sensitized animal absorbs the corresponding antigen. The stellate cells of Kupffer are assumed to be the active agents in the liver. Ehrlich and Morgenroth¹⁴ observed that in dogs poisoned by phosphorus, with a consequent degeneration of the liver, there was a diminished production of alexin or complement. Although later experiments have not by any means settled these questions, there can be no doubt that the reticulo-endothelial system, and consequently the stellate cells of the liver, play an important part in the taking up and destruction of bacteria and in the altered reaction of the body to introduced bacteria.

If next we turn to the circumstances under which bacteria invade the tissues and settle in the liver and consider that, aside from the fact that in very many infections where organisms are introduced through the skin or through the genito-urinary system, the respiratory system, the mouth, the pharynx and oesophagus, and in which bacteria gain entrance into the systemic

circulation and are widely distributed, there is a large group where invasion occurs through the portal system

Numerous observers have studied the intestinal flora. We all know that multitudes of bacteria, aerobic and anaerobic, inhabit and flourish in the large intestine and the lower portion of the small intestine, becoming less and less under normal conditions as the upper jejunum is reached. The intact epithelial cells, the protective mucus, the continual movement onward of the intestinal contents, all prevent the passage of bacteria through the intestinal wall. Slight alterations, such as congestion or catarrhal inflammation and demonstrable morphological lesions may, of course, alter conditions so that the intestinal wall is penetrated. Fifty years ago Pasteur and his collaborators showed that the anthrax bacillus which is so fatal for mice and guinea pigs, could be swallowed with impunity. To produce anthrax invasion by the path of the intestine it was necessary to feed the animals powdered glass and sand.

I wish, however, to call your attention to a number of experiments which show that bacteria can pass through the normal intestinal wall. There is mention by Metchnikoff¹⁵ of an unpublished paper by Mitchell on experiments carried out in his laboratory, in which animals were killed by the invasion of anthrax bacilli through the intestinal mucosa, to all appearances normal and in which the animals received no nourishment capable of producing lesions of the intestinal wall. The animals were fed anthrax spores mixed with a pap of bread soaked in milk. In 1894, Macallum,¹⁶ in studying the absorption of iron, showed that leucocytes could pass out into the intestinal lumen, take up foreign material and return through the intestinal wall. He recovered the leucocytes containing stained granules in the liver and spleen. The leucocytes found their way into both the systemic and portal circulation. The next year, Desoubry and Porcher¹⁷ working in Nocard's laboratory, established by numerous experiments that during digestion bacteria of all kinds may pass through the normal mucous membrane of the intestines and may be found during several hours in the chyle and blood. These experiments were made at the suggestion of Nocard, who had noticed that serum obtained from blood withdrawn with every possible care from horses shortly after feeding was, every now and again, contaminated.

In studying the pathogenesis of tuberculosis a number of experimenters have confirmed these observations. During digestion many bacteria pass through the intestinal mucosa with the chyle and are found in the mesenteric glands, in the lymph of the thoracic duct, in the blood current and in the liver, spleen and bone-marrow. The younger the animal the more constant the results. The bacteria find their way through the mucous membrane of the intestinal wall without leaving a trace of their passage. Calmette and Van Steenberghe¹⁸ studied the mechanism of passage. They confirm the observations of Macallum. Polymorphonuclear leucocytes in large numbers pass through the mucosa into the lumen of the bowel normally. They form with the epithelial debris a not inconsiderable part of the faeces. Attracted by chemotaxis to the surface of the intestine and the secreting surfaces of the

glands, hundreds of thousands pass out daily. Bacteria in the intestinal lumen are taken up by some of these phagocytic cells. During digestion, especially when bacteria are intimately mixed with the food, the bacteria are carried by the leucocytes back through the intestinal wall to enter with the minute globules of fat or the salts of fatty acids, made by breaking up the fats, into the lymph vessels of the villi of the small intestine and hence to the systemic circulation or they find their way to a less extent into the capillaries of the villus and to the portal circulation.

The bacteria taken in may be destroyed by the intracellular ferments of the leucocytes, or the leucocytes containing microbes may be arrested and destroyed in the submucous lymphatics or in the lymph-nodes. However, not infrequently living bacteria reach the liver and are destroyed there. Ford¹⁹ showed that 70 per cent of the livers removed aseptically a minute or two after death yielded cultures of microbes similar to those found in the intestine. The bacteria seemed to be feeble and attenuated and were slow to grow. The presence of tetanus antitoxin in the serum of individuals who carry tetanus bacilli in the digestive tract has been shown by Ten Broeck and Bauer²⁰. They showed spores of tetanus bacilli in 34 per cent of the stools of 78 individuals in Peking. May it not be assumed that here we have an instance of a reaction being set up by spores absorbed during digestion and carried to the liver? Obviously, the nature of the bacillus, the character of the food, the species of animal, may all cause wide variation. The fatty and waxy coating of the tubercle bacillus, for example, makes it particularly resistant to the intracellular ferments of the leucocytes.

The question as to the reaction set up in the liver by the lodged bacteria is equally interesting. That bacteria, without the signs of tissue reaction, can be found in both the liver and the gall-bladder, has been pointed out by Aschoff²¹. He had a large number of unchosen livers examined for possible inflammatory reactions. He concludes that although staphylococci, streptococci and pneumococci can be more or less frequently demonstrated bacteriologically, yet the gall-bladder and the intrahepatic bile passages may be normal in appearance and therefore that certain bacteria may be excreted through the liver and perhaps through the gall-bladder without a special reaction.

Adam²² pointed out that, in conditions of congestion and slight chronic inflammation, bacteria may, time after time, pass through the intestinal wall to be deposited and destroyed in the liver. The microbes may not necessarily multiply in the organ. Repeated inroads and repeated destruction of bacteria, however, yield enough toxic substances to produce an appreciable alteration in the parenchymatous cells. He suggested the term *subinfection* to describe the reaction.

The reaction in the reticulo-endothelial cells, when considerable numbers of microbes are introduced into the blood, has been made the subject of an interesting study by Oerskov²³. He used more or less virulent strains of streptococcus, staphylococcus, pneumococcus and bacillus coli. He destroyed

the animals at varying intervals from five minutes to several days after the injection. He studied the amount of phagocytosis by the Kupffer cells and the amount of exudation of leucocytes. He found in animals killed after two minutes many cocci in the liver and a few in the spleen. The cocci were largely inside the Kupffer cells. The leucocytes were few. In an hour and a half all the Kupffer cells were packed with cocci and there was a considerable exudation of leucocytes. At the end of six hours the liver contained a great number of cocci and the leucocytes were in great numbers. At the end of eighteen hours there were still a large number of microbes in the liver but many of them stained poorly, the leucocytes were numerous. At the end of eight days the microbes were no longer found. In the destruction of the cocci by the Kupffer cells there was pronounced infiltration of the interstitial tissue with leucocytes, similar results were obtained in studying the destruction of other microbes. None of the polymorphonuclear leucocytes showed evidence of phagocytic activity.

In another series he introduced a fatal dose of pneumococci. The results were similar up to a certain time. The cocci were rapidly arrested and destroyed in the liver by the Kupffer cells, accompanied by the same infiltration of the interstitial tissue by leucocytes, but at the end of twenty-four hours there was a multiplication of the pneumococci. The protective cells were unable to hold in check the microparasites and the body was invaded.

According to the type of organism and the degree of immunity established in the body, not only an exudative inflammation occurs, but various forms of degeneration, necrosis and regeneration, and various forms of productive inflammation, giving the most varied picture of interstitial and parenchymatous lesions.

Chronic productive inflammation of the interstitial tissue is very frequent and leads to a variety of alterations in the liver tissue which are grouped under the general heading cirrhosis.

There is a wide margin of safety in the liver. Rous and MacMaster²⁴ have shown in the dog and the monkey that three-fourths of the secreting cells of the liver can be shut off without producing symptoms. That considerable cirrhosis can exist without clinical symptoms has long been well recognized.²⁵

There can be no question that the liver is concerned in the defense mechanism of the body. It is concerned normally in the disposal of and making innocuous various substances brought to it, in the exaggeration of this function various reactions occur which are shown morphologically. The liver seems to be one of the first organs to react and forms a first line of defense as it were in the protection of the body against disseminated bacteria.

Many of these reactions pass without evidence of disturbance, such as fever etc. which can be recognized clinically. There is an interesting hypothesis of Vaughan²⁶ in this connection. He suggests that when bacteria are destroyed the general body reaction, the heightened metabolism, the rise of body temperature, all the general disturbances that we group under fever,

are due to the disintegration of foreign bacterial proteins by extracellular ferments. The destruction of bacteria inside the cells may be unaccompanied by these phenomena. The intracellular ferments in the macrophages (Von Kupffer cells) carry perhaps the destruction of the bacterial proteins to a point where the products are much less toxic or build them up into their own protein. The process of intracellular digestion may pass so smoothly that the host may be unaware of the bacterial destruction going on and present no disturbance of the normal working of the body that can be recognized clinically.

The large phagocytic cells of the reticulo-endothelial system have another function. They are concerned in the destruction and disposal of red blood-cells. This has been shown to take place normally in the liver, the spleen, the bone-marrow and the lymphatic nodes. The hæmoglobin is split into an iron-containing portion and an iron-free portion and the liver seems to play an important part in the disposal of both portions. When the red cells are destroyed in excess the iron accumulates in the liver. The iron produced in excess in the reticulo-endothelial system is released into the circulation and stored and slowly secreted by the liver cells. It shares this function of storage with the spleen and takes it over when the spleen is removed.

The disposal of the iron-free portion has been the subject of much study. It is concerned in the production of bilirubin. There has been much controversy over the site of the formation of bile pigment and the production of jaundice. In the well-known experiments of Naunyn and Minkowski²⁷ the liver was removed from a goose, then the bird was poisoned with arseniureted hydrogen. No icterus followed. In another experiment the liver was not removed. In this instance poisoning by arseniureted hydrogen resulted in an enormous phagocytosis of erythrocytes and the production of jaundice. The text-books of physiology of fifteen years ago record the famous experiments. But as almost all the reticulo-endothelial cells in birds are in the liver, the spleen and bone-marrow containing relatively few cells of this system, these experiments were inconclusive when applied to mammalia.

Later, Whipple and Hooper²⁸⁻²⁹ excluded the portal circulation in dogs, injected hæmoglobin and were then able to show bile pigment in the urine, and Mann and Magath³⁰ observed the formation of bilirubin in dogs after the removal of the liver. The text-books of physiology of the future will record these experiments. It seems to be established to-day that one of the functions of the reticulo-endothelial system is the production of bilirubin. The Kupffer cells of the liver make up an important part of this system, so that although there is an extrahepatic formation of bilirubin, it by no means implies that the liver is not the seat of a considerable portion of bile pigment production. Of the polyhedral cells of the liver it may perhaps be said that the evidence to-day is against their ever sharing in the formation of bilirubin. They excrete the pigment but do not form it. The bilirubin made by the reticulo-endothelial cells seems to be slightly different from the bilirubin secreted by the liver. Van den Bergh³¹ showed that these differences could

be detected by the behavior of the pigment in the diazo reaction. These differences are possibly due to physical changes in the state of the bilirubin in the plasma. The bilirubin acted on by the liver cells diffuses more readily and is more readily oxidized. It gives what is known as the immediate or direct reaction. The bilirubin, as it is formed by the cells of the reticulo-endothelial system, diffuses less readily and is less readily oxidized. It gives a delayed or indirect reaction.

Concerning the secretion of bile salts and cholesterol, little definite is known. It is assumed by Brule³² and a number of French observers that the polyhedral cells have a selective action, very much as the secreting cells of the kidney have. At times, when the cells are damaged, now one, now another ingredient is not excreted by the polyhedral cells so that there may be the presence of bile salts alone or bilirubin alone in the blood. There is not always a complete retention of all the component parts of the bile. Unfortunately the tests for the detection of the bile salts in the urine are open to criticism. However, his work is interesting and suggestive. The itching, the brachycardia, the absorption of fat, are all said to be due to bile salts. He thinks obstructive jaundice is "globale et brutale", both salts are retained completely and suddenly. In hepatitis from various toxic substances the dissociation of the two substances found in the bile exists, now one, now the other appearing in the serum, then both appear, and again in the disappearance of the jaundice there is a similar irregularity.

The liver is, as we have said, concerned in the storage and detoxication of various substances besides bacteria. When colloidal metals are injected into the circulation they are taken up by the Kupffer cells. If the dosage is sufficient the cells are injured. The damaged function is made evident by the clinical sign of jaundice and the extent and character of the jaundice is, in a way, a measure of the impairment of the liver cells. Cunningham,³³ in studying the clinical effects of colloidal lead in patients to whom it had been administered for inoperable carcinomata, describes three forms of jaundice.

I. There is a slight icteric change in the sclera with increased urobilin and a positive indirect or delayed direct Van den Bergh reaction. The bile secreting cells are probably unaffected. The jaundice is due to excessive production of hæmolysis by the Von Kupffer cells and the reticulo-endothelial system. The pigment is produced in too large quantities to be taken up directly and secreted by the polyhedral cells of the liver parenchyma, with the result that a quantity continues to circulate in the blood.

II. There is damage to the polyhedral cells of the liver. urobilin and bile appear in the urine, the jaundice is deeper, the Van den Bergh reaction is biphasic or of direct type.

III. In the third type there is evidently a cholangitis in addition, due to the destruction of the polygonal cells. Jaundice is deeper and there are large amounts of bile in the urine. There may or may not be an increase of bilirubin of the urine, the van den Bergh test is immediate or direct.

These studies seem to me of especial interest. They furnish an indication of the way certain toxic substances act in producing jaundice by direct action on the reticulo-endothelial cells and on the polyhedral cells of the liver. We have in jaundice an obvious clinical sign and in certain cases, an indica-

Various microbes not only settle out and are taken up by the liver cells in the course of disseminated infection, but reach the interstitial tissue of the liver in clumps or masses from a disintegrating, infected clot in the portal vein or by emboli through the hepatic artery, being arrested in the small vessels and producing a variety of focal lesions and multiple or single abscesses

It has long been recognized that patients suffering from amœbic dysentery not infrequently develop liver abscesses. The amœbæ spread in the sub-mucosa of the intestines. They may be found both in the blood-vessels and lymphatics, to be carried to the mesenteric lymph-glands or through the portal circulation to the liver, where they set up a hepatitis. The hepatitis may subside or, if the tissue resistance is poor or the dosage massive, abscesses form. Here again the liver is the first great barrier to the dissemination of the infecting agent³⁸

In many of the stages of infection when a partial immunity has been established, various forms of hepatitis occur, often giving little or no clinical evidence of their presence. According to Calmette,³⁹ during the course of infection with tubercle bacilli, small tuberculous lesions are nearly always present in the liver if careful enough search is made. In an autopsy reported by Sabrazes,⁴⁰ in a patient who died of leprosy, the liver showed no leprous nodules, but sections showed an enormous phagocytic reaction of the Kupffer cells. There were no bacilli, however, in the biliary passages, none in the bile. In late stages of syphilis the liver more frequently harbors treponemata than any other organ. Various forms of interstitial hepatitis, as well as the characteristic gummata, are present. Syphilis is relatively frequent. In over nine thousand Wassermann tests, taken as a routine measure in all patients treated at St. Luke's Hospital during the last year, including the out-patient department, over five per cent showed a positive reaction. As in a number of these repeated examinations were made and as there must be a large number with syphilitic infection, yet showing a negative examination, the actual percentage should be put much higher. It would be interesting if we knew in how many of these patients there were changes in the liver, due to the lodged treponemata.

Anyone connected with a large hospital has an opportunity of seeing all these forms of hepatitis. He gets an impression of an extraordinarily complex etiology.

With these facts in mind, I shall next attempt to study the path of infection suggested in a number of recent papers and the relation of hepatitis to cholecystitis and then of cholecystitis to hepatitis.

In the first place there is a widespread notion that appendicitis, hepatitis and cholecystitis are related and that infection passes from the appendix to the liver through the portal vein. That this relation occasionally exists, in acute cases in which there is a suppurative lesion of the veins in the mesentery of the appendix and a progressive suppurative pyelophlebitis is set up, which leads to infected clots lodging in the liver, is generally recognized. But during the course of acute appendicitis, cholecystitis and hepatitis are not usually

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recognized. The associated acute lesions occur, but they are not common. I do not find, in patients operated on for acute suppurative appendicitis, any disproportionate number later developing clinically recognizable forms of hepatitis. Nor do the autopsy records on patients dying of acute appendicitis as a rule show lesions of the liver. Tens of thousands of microorganisms are undoubtedly lodged in the liver, just as they are in the spleen and the bone-marrow in general sepsis from acute appendicitis. They are taken out of circulation and many of them are destroyed in these situations. Nor is the proof offered that hepatitis has been found, in removing sections of liver while performing appendectomy for chronic appendicitis, convincing. The sources of error are obviously too numerous, the impossibility of excluding other inciting agents is too great, the number of observations are too few.

Nor do I find evidence that cholecystitis regularly follows hepatitis. In the numerous instances of infective hepatitis I can find only occasional instances of involvement of the gall-bladder which reaches the grade of clinical recognition. Although hundreds of thousands of microbes are lodged in the liver there is only very exceptional evidence of acute cholecystitis. I do not question that if these patients were operated on, various slight degrees of round-celled infiltration of the wall of the gall-bladder might be found, but during the course of the jaundice that is so frequently present in infective hepatitis there is rarely present a form of cholecystitis that can be recognized clinically.

During the last year I have twice operated through a mistake in diagnosis on patients with infective hepatitis. A woman aged thirty-seven years, entered the hospital acutely ill with a temperature and jaundice. She was kept under observation. There was a history of syphilitic infection and treatment by salvarsan five months previously and, although she had had little pain, having only a sense of fulness and distention after meals, and gave no history of having had attacks suggesting cholecystitis, the erroneous conclusion was reached that she had an obstructive jaundice. On opening the abdomen the gall-bladder was full but could readily be emptied. There were no adhesions, the wall was thin, there was no dilatation of the ducts, the liver seemed a little firm. A section removed for examination showed the lesion of severe, extensive hepatitis, the lesion extending about the minute bile ducts and about the portal venules. The gall-bladder was anastomosed to the stomach. The patient made a good recovery, the jaundice very slowly subsided, as is the rule in infective jaundice. There was marked hepatitis, proved by the microscopic section, and no appreciable cholecystitis. The second case was similar. The patient had an infective hepatitis imposed upon a cirrhosis of the liver.

The following case report is in point. A man aged forty-one years, entered the hospital very ill with fever and general abdominal pain. He was slightly jaundiced. The abdomen was opened through a right rectus incision, the gall-bladder seemed normal, a

gangrenous retrocaecal appendix was discovered and removed. He grew gradually more jaundiced and died on the second day. During the last day he complained bitterly of pain in his right leg. At autopsy the liver showed marked hepatitis. The common duct was patent and there was no dilatation. The cystic duct was patent, there was no gross lesion of the gall-bladder. There was infection of the retroperitoneal tissue, the psoas muscle was soft and pultaceous. Cultures from the retroperitoneal infection showed a large non-gas-forming bacillus. This patient is an example of hepatitis following appendicitis, yet advanced acute hepatitis was unaccompanied by gross lesions of the gall-bladder.

In typhoid fever the relation of hepatitis and cholecystitis has attracted much attention. The initial period of typhoid fever is accompanied by the presence of typhoid bacilli in the blood stream. After a time the bacilli are no longer found in the blood. They are found in the bone-marrow, spleen, lymphoid tissue of the intestine and lymph-glands of the mesentery. In the lymphoid tissue of the intestine they colonize, multiply and produce the characteristic lesions of the disease. The livers of patients dying of typhoid regularly show changes, there is fatty degeneration, infiltration with leucocytes, masses of leucocytes about degenerated and fragmented liver cells. These nodules are said to be due to bacterial emboli.⁴¹ At times there is acute diffuse hepatitis or massive fatty degeneration, some of these patients are jaundiced and the jaundice, to quote Widal, is due to a hepatitis. "The jaundice of typhoid is really a hepatitis, the result of lesions of the hepatic cells, determined by the localization in the liver of microbes deposited there from the general circulation."⁴² The bile regularly contains typhoid bacilli and there are all grades of lesions of the gall-bladder, from catarrhal to purulent inflammation, yet cholecystitis giving clinical symptoms is not common in typhoid fever. From the seventh to the thirtieth day pain in the right hypochondrium, tenderness and rigidity are the symptoms that all who have an opportunity to see any considerable number of patients suffering with typhoid, associate with the condition. Though thousands of micro-organisms are in the blood stream and the liver and although the gall-bladder wall frequently shows lesions, only occasionally do symptoms appear that bring the lesions into the plane of clinical observation. Other factors seem to be necessary. One would expect that occasionally bacterial emboli might be lodged in the wall of the gall-bladder. One would expect that occasionally bacteria would be carried by the lymph stream to the wall, but it is difficult not to believe that the thousands of organisms in the infected bile must play a most important part in producing lesions of the gall-bladder. The experiments of Nichols are suggestive.⁴³ He succeeded in 63 per cent in producing gall-bladder lesions when injecting typhoid bacilli by the mesenteric vein and in 41 per cent when injecting into the systemic veins. There was a considerably higher percentage of gall-bladder infections occurring in the immune animals than in the normal animals. He brought forward the view that gall-bladder infections in inoculated animals are not necessarily an index of immunity, but may be in part an indication of a rich amount of immune bodies in the blood.

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The colon bacillus, aside from infection of the liver following stones lodged in the common duct and consequent infective cholangitis, can, in exactly similar manner, cause jaundice. The following autopsy report is an example. The skin was jaundiced, the liver showed acute hepatitis, the common duct was normal in appearance, the gall-bladder showed a subacute lesion. There was extensive degeneration of the liver cells and central necrosis, yet the gall-bladder showed only a subacute lesion. Cultures taken from the gall-bladder bile showed colon bacilli.

In the purulent form of interstitial hepatitis it is curious to see the absence of correspondence in the lesions of a gall-bladder and the lesions of the liver. A child, ten years old, very ill, was admitted to the hospital. She had a high temperature, tenderness and an indistinct feeling of mass in the right hypochondrium. The abdomen was opened, the liver was found enlarged, the gall-bladder seemed acutely inflamed. It was removed. The patient died in three days. At autopsy there was only a small amount of serous fluid in the upper part of the abdomen. There were no signs of peritonitis. The liver was enlarged and riddled with abscesses. There was an early parietal clot forming in the portal veins. Section of the gall-bladder removed at operation showed a subacute cholecystitis. Although the liver was filled with abscesses, some of them but a few centimetres from the gall-bladder, only enough bacteria had passed through the lymphatics to set up a subacute lesion. Cultures from the pus in the abscesses showed colon bacilli.

In amoebic abscesses I have been unable to find records of gall-bladder involvement. Although tubercular lesions of the liver are said to be common, tuberculosis of the gall-bladder wall is rare. Simmonds⁴⁴ has given a description of the forms. In syphilis, although various forms of hepatitis are common, there is no evidence of unusual frequency of clinical forms of cholecystitis. As I understand the evidence, there is no unusual incident of gall-bladder infection following the various forms of hepatitis. Bacteria are probably not infrequently present and not infrequently there are slight evidences of an inflammatory reaction. To produce a clinical form of cholecystitis, added factors are necessary.

If the gall-bladder is grossly infected, if the bacteria are lodged in its wall and the tissues react and the lumen is filled with exudate and bile, does a form of hepatitis develop, leading to clinical forms of cirrhosis? A reacting zone of contiguous structures is formed about the inflamed organ. The peritoneum, the wall of the colon and the duodenum are glued to the gall-bladder by exudate. The omentum turns up and is adherent to the gall-bladder and the edge of the liver, the cellular tissue between the gall-bladder and the liver reacts and the interstitial tissue of the liver reacts. The extent of the zone of circumscribing reaction depends, as in all infections, on the virulence of the lodged organisms and the local and general resistance. There are all grades of severity from inflammatory changes that can hardly be detected by microscopical study to changes where purulent exudate and ulceration and necrotic processes are the characteristic features, and in all

of them the liver in contact with the gall-bladder shows varying grades of hepatitis. Moreover, if the attacks are repeated there may be evidences of chronic interstitial inflammation. Sections taken of the quadrate lobe or the right lobe in the neighborhood of the infected gall-bladder regularly show signs of inflammation on microscopical examination.

Anyone who has operated on a number of gall-bladders recognizes, as a matter of course, the infiltration of the cellular tissue between the gall-bladder and the liver, succulent in fresh infection, dense and firm in long-standing cases. When the gall-bladder ulcerates or is necrotic at some point an abscess may form partially in the liver substance. There can be no question that some form of local hepatitis occurs in almost all infections of the gall-bladder and that the infection travels from the gall-bladder to the liver. It is a matter so generally accepted that it has rarely been emphasized. It is part of the pericholecystitis nearly always present. Specimens, however, have been taken in many instances far enough away from the bed of the gall-bladder to indicate that the reaction is widespread. There is no means of knowing in these instances whether the reaction in the liver may not be due to one of the many irritants which reach the liver. This may readily be the case if the gall-bladder lesion does not present gross morphological changes. In any event, the hepatitis which we see so frequently at operations for cholecystitis does not seem to have clinical significance, for if the grossly inflamed gall-bladder is removed there is no progressive involvement of the liver. In several cases in which I have removed a gall-bladder with an abscess between the gall-bladder and the liver, the infection in the liver has apparently promptly subsided, for these patients are in good health and fat when seen years after their operations.

A patient entered the hospital two years ago presenting several interesting features. He had a bottle in his hand containing gall-stones that he had passed twenty years ago. He had had, after this long period of latency, a severe attack of typical gall-bladder pain. Twenty-seven years ago he had had his first attack and during seven years following had had a number, several of them with jaundice. During the last one of these attacks he passed the stones he showed. He was operated on by Doctor Bolling and an obviously inflamed gall-bladder was removed, containing stones in every way similar to the ones he had passed many years before. The liver seemed firm and the edge a little rounded. The wall of the gall-bladder showed a small carcinoma. He had at that time and still has, two years later, no signs of chronic hepatitis or liver cirrhosis that can be appreciated clinically, although there had been enough irritation to produce a new growth, and although the irritating agent had acted over a period of twenty-seven years.

There is another bit of evidence worth recording. Fifteen years ago, in a number of the large clinics, the gall-bladders were not removed. The stones were removed and the gall-bladder drained. The practice was abandoned. There were too many recurrences due to impacted stones or stenosis of the cystic duct. Many of these patients recovered. I can recall no instance

or report of the retained, grossly infected gall-bladder setting up chronic forms of hepatitis. I gained the impression at that time that a draining gall-bladder, even if infected, gave little or no symptoms.

In deeply jaundiced patients with septic fever and a stone in the common duct, I have in several instances left the shrunken gall-bladder in place, opened the common duct and removed the stones. In no instance has a progressive hepatitis or liver cirrhosis followed.

I do not find evidence, then, of a so-called vicious circle, a chronic appendicitis, then a hepatitis, then a cholecystitis and the cholecystitis then becoming the main focus and producing hepatitis. The evidence seems to be that the liver is a most efficient filter for bacteria, taking them up from the general or portal circulation and that only a few pass the cells of the peculiar liver capillaries to reach the lymph and float along with the lymph current into the nodes at the hilus. At autopsy or at operation these nodes are not infrequently enlarged, but the enlargement of the lymphatic nodes is an inconspicuous feature of infective hepatitis. I do not question that a few bacteria may pass along the lymphatics from the liver into the wall of the gall-bladder. I do question, however, whether slight infiltration of the gall-bladder wall, changes so slight that it is impossible to recognize them by gross examination, are clinical forms of cholecystitis. This assumption seems to be based on the observation that certain patients gain relief from symptoms of a form of dyspepsia after the removal of a gall-bladder which shows no macroscopic lesions or shows beneath the mucosa, when cut open, small yellow spots from lipoid deposits (strawberry gall-bladder). This form of indigestion is shown by accumulations of gas in the upper abdomen, belching, sour regurgitations occurring promptly after eating a hearty meal or badly prepared or indigestible food.⁴⁰ Unfortunately these symptoms are present to some degree in most middle-aged people. They are present, as I have assured myself, at times after the gall-bladder has been removed and they are absent in many instances in which there is a gross lesion of the gall-bladder wall.

In the same way study of the cholecystograms, made by the method recently introduced by Graham, has been said to furnish a surer means of recognizing gall-bladder disease than the sight and touch of the surgeon at operation, that is, by the observation of the filling and emptying of the gall-bladder one can determine whether a gall-bladder is so diseased that it should be removed, even if there is no demonstrable lesion at operation. The gall-bladder disease is proved by the microscopic examination of the excised gall-bladder wall showing a very slight cellular infiltration and by statements made by the patients of relief after operation. But is it not too early to draw this conclusion, is not too little known of the normal function to speak so confidently of abnormal functions? I grant that certain patients get complete relief after operations for the removal of the gall-bladder with very trifling lesions of the gall-bladder wall but a more or less lasting freedom from symptoms has been presented as proof for all manner of remedies. Patients treated by homeopathy and osteopathy are sincere in their belief

in the remedies applied and grateful for the relief afforded I believe we should demand stronger proof I have an instinctive distrust of occult surgery or surgery for occult lesions I recently saw a middle-aged woman operated on in a large clinic Her symptoms were, as nearly as I can remember, gas, indefinite gastric discomfort, inability to eat certain foods, and pain after eating When the gall-bladder was exposed it was soft, thin-walled, on manipulation it emptied, there were no adhesions, no stones The gall-bladder takes up and concentrates bile and regulates the pressure in the biliary system⁴⁷ If the orifice of the cystic duct is blocked, there is evidence of disturbance and pain The gall-bladder in question emptied, it was thin-walled and distensible It contained stasis bile Which of its known functions was at fault? The gall-bladder was removed, it was cut open and from the appearance of the thick, stringy stasis bile, cholecystitis was said to be present

The pathologist, Aschoff,⁴⁸ whose painstaking and thorough studies have thrown so much light on the formation of gall-stone and the function and structure of the extrahepatic bile passages, has pointed out that in studying post-mortem staining of the biliary passages there are fairly constant findings The region of the sphincter of Oddi is usually pale, almost colorless, a sign that it is closed, even after death The common and hepatic ducts and the cystic duct up to the neck of the gall-bladder are stained yellow, that is, stained with hepatic bile, while the neck and the rest of the gall-bladder are stained dark brown by the stasis bile of the gall-bladder as if the change in color marked a division between the conducting system and the condensing system of the extrahepatic bile passages He also points out that there is sphincter-like thickening of the smooth muscles at the beginning of the cystic duct and numerous ganglion cells and nerve fibres in the wall of the cystic duct We apparently have to think not only of the mechanism of control at the orifice of the common duct, but of a mechanism of control at the outlet of the gall-bladder That among the patients in whom the gall-bladder has been removed for trifling lesions and in whom the cysticus is patent, there are a few who have had definite cramp-like attacks due to disturbance of the nervous control mechanism which synchronizes the various sphincter-like structures at the orifice of the cystic and at the orifice of the common duct, seems very probable But in the great majority of cases, to produce a clinical form of cholecystitis, either very unusual virulence of the microorganisms is necessary or there is added to the factor of slight infection a disturbance either mechanical (calculus, anatomical peculiarities, etc), or functional, which interferes with the passage of the gall-bladder contents through the cystic duct

TO SUMMARIZE

I One of the main functions of the liver is the destruction and disposal of bacteria and toxic substances

II Bacteria and toxic material reach the liver in a great number of ways and very frequently throughout life

III Some are destroyed there without appreciable reaction and all grades of appreciable reaction occur

IV The morphological changes which occur in the liver in the reaction of the cells to irritants and which are called by the pathologist hepatitis are extremely difficult to classify. The subject of hepatitis is one of the most complex in the domain of pathology. It is in no sense an entity nor can it be discussed with profit as an entity.

V Many of the cases formerly grouped under acute catarrhal jaundice are now considered forms of infectious hepatitis.

VI In the forms of hepatitis which have reached the level of clinical observation there is little evidence of a relation to clinical forms of cholecystitis.

VII The hepatitis regularly found with cholecystitis has little or no clinical significance and is not a factor of importance in causing clinical forms of liver cirrhosis.

VIII The proof that very slight infiltration of the gall-bladder wall and lipid deposit in the mucosa cause acid indigestion, a feeling of fulness in the epigastrium, flatulence, intermittent gastric pain after eating badly prepared food, is by no means conclusive.

In closing, may I quote the following letter of advice to a young noblewoman from Burton's *Anatomy of Melancholy*: "In this hypochondriacal or flatuous melancholy the symptoms are so ambiguous that the most exquisite physicians cannot determine of the part affected." The symptoms of this disease are said to be "sharp belchings, fulsome crudities, heat in the bowels, wind and rumbling in the guts, vehement gripings, pain in the belly and stomach sometimes, after meat that is hard of concoction." I am not sure whether Burton's rendering is better than the original Latin, which I add: "*Acidi iuctus, cruditates, æstus in præcordis, flatus, interdum ventriculi dolores vehementes, sumptoque cibo concoctu difficili*."

BIBLIOGRAPHY

- ¹ Graham. Hepatitis a Constant Accompaniment of Cholecystitis. Surg, Gyn and Obs, 1918, vol xxvi, p 521
- ² Graham. Further Observations on the Lymphatic Origin of Cholecystitis. Arch of Surg, 1922, vol iv, p 22
- ³ Graham. New Developments in Our Knowledge of the Gall-bladder. Am Jour Med Sc, 1926, vol clxxii, p 625
- ⁴ Aschoff. Concept of Inflammation. Lectures on Pathology, 1924, p 74
- ⁵ Krogh. The Anatomy and Physiology of Capillaries, 1922, p 64
- ⁶ Schafer. Essentials of Histology, 1920, p 364
- ⁷ Sappey. Les Lymphatiques, Traite d'Anatomie, Poirier, 1909, p 1226
- ⁸ Roger. Physiologie Normal et Pathol du Foie, 1922
- ⁹ Graham. Resistance of Pups to Late Chloroform Poisoning in Relation to Glycogen. Jour Exp Med, 1915, vol xvi, p 125
- ¹⁰ Wyssokowitsch. Ueber schikasse der m's blut injicirten mikroorganismen, im korper der warmbluter. Zeitsch f Hyg, 1886, vol 1, p 3

- ¹¹ Nichols Experimental Observations on the Pathogenesis of Gall-bladder Infection in Typhoid, Cholera and Dysentery Jour Exp Med, 1916, vol XLIV, p 497
- ¹² Metchnikoff L'Immunité, 1901, p 421
- ¹³ Hahn, Von Skramlik and Huenermann Aschoff, Reticuloendothelial System Ergebnisse inn med und kinder, 1924, vol XLVI (Bibliography)
- ¹⁴ Ehrlich and Morgenroth Zinsser's Infection and Resistance, 1923, p 189
- ¹⁵ Metchnikoff L c, p 444
- ¹⁶ Macallum Jour of Physiol, 1894, vol XLVI, p 288
- ¹⁷ Desoubry et Porcher De la presence de microbes dans le chyle normal chez le chien Soc de Biol, 1895, p 101
- ¹⁸ Calmette and Van Steenberghe Annals of Pasteur, 1910, p 316
- ¹⁹ Ford Jour of Hyg, 1901, vol I, p 276
- ²⁰ Ten Broeck and Bauer Studies in the Relation of Tetanus Bacilli in the Digestive Tract to Tetanus Antibodies in the Blood Jour Exp Med, vol XLVIII, p 47
- ²¹ Aschoff Extrahepatic Bile Passages, Lectures on Pathology, 1924, p 205
- ²² Adams Subinfection Jour A M A, 1899, vol XLVIII, pp 1506-1572
- ²³ Oerskov Observations sur la propriete phagocytaire Comptes Rendus, Soc de Biol, 1925, p 959
- ²⁴ McMaster and Rous Biliary Obstruction Required to Produce Jaundice Jour Exp Med, 1921, vol XLIII, p 731
- ²⁵ Delafield Lectures on the Practice of Medicine, p 784
- ²⁶ Vaughan Poisonous Proteins, 1917, p 86
- ²⁷ Naunyn and Minkowski Luciani, Physiologie Dell'uomo, vol II, p 165
- ²⁸ Whipple and Hooper Jour Exp Med, 1913, vol XLII, pp 593-612
- ²⁹ Whipple and Hooper Jour Exp Med, 1916, vol XLIII, p 137
- ³⁰ Mann and Magath Effect of Total Removal of the Liver Transactions of Section on Path and Physiol Jour A M A, 1921, p 29
- ³¹ Van den Bergh La Presse Medicale, 1921, p 45
- ³² Brule Recherches sur les ictères, 1922, p 240
- ³³ Cunningham The Clinical Effect of Lead in the Treatment of Carcinoma Brit Jour of Med, Nov 30, 1926, p 931
- ³⁴ Inada and Ido Etiology and Mode of Infection of Weil's Disease Jour Exp Med, 1916, vol XLIII, p 377
- ³⁵ Blumer Infectious Jaundice in the United States Jour A M A, 1925, vol LXXV, p 353
- ³⁶ Eppinger Path der icterus catarrhal Wein Klin Wochen, 1908, vol LXXI, p 480
- ³⁷ Drury and Rous Suppression of Bile as a Result of Impairment of Liver Function Jour Exp Med, 1925, vol XLII, p 611
- ³⁸ Phillips Amoebiasis, p 32
- ³⁹ Calmette L c, p 193
- ⁴⁰ Sabrazes Leprose Massive de la Rate et du Foie, Comptes Rendus, Soc de Biol, 1925, vol LXXV, p 1526
- ⁴¹ Widal, Lemierre et Abrams Maladies Infectieuses, 1924, p 73
- ⁴² Widal, Lemierre et Abrams L c, p 123
- ⁴³ Nichols L c
- ⁴⁴ Simmonds Verhandl d deutsche path gesellsch, 1910, vol XLIV, p 332
- ⁴⁵ Hartman Diseases of the Biliary System Coll Papers Mayo Clinic, 1923, vol XLV, p 148
- ⁴⁶ Graham L c³
- ⁴⁷ Rous and McMaster Concentrating Activity of Gall-bladder Jour Exp Med, 1921, vol XLIV, p 47
- ⁴⁸ Aschoff Über Ortho and Pathol der extrahepatischen gallenwege Archiv f Klin Chir, 1923, vol CXXVI, p 245

PRE-OPERATIVE AND POST-OPERATIVE TREATMENT OF THE GALL-BLADDER PATIENT

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IN SCANNING the history of gall-duct surgery one is impressed by the influence of simple mechanics upon the early period, and the complex chemical problems being worked out in conjunction with the surgery of to-day. The earliest period, or stone age, produced a type of surgery which had for its purpose removal of an obstruction to the cystic or common duct. Cholecystostomy and choledochotomy were practiced for the removal of stones without due consideration for recurrence, or the effect upon the liver and adjoining organs of the diseased gall-bladder which remained. The second period, or local infection age, produced a type of surgery planned for the removal of stones and prevention of their recurrence. During this period the local infectious influence of a diseased gall-bladder was revealed. The last and present period, or chemical age, although not completely developed, demands that the surgeon in planning operative procedures upon the gall-ducts include all those principles of the earlier periods with the changes in internal metabolism which have taken place as a result of disease of the liver and gall-ducts. Another factor of this period is the influence upon the liver and its function of infectious disease in other organs.

The preparation for operation and the after-care during the first and second periods were not specific for patients with liver disease. The general measures in use at that time were developed from the experience of surgeons in operations of all kinds. Acute infection as cholecystitis and cholangitis played a specific part in this instance in the preparation of the patient by delaying the operation for the infection to become encysted and attenuated in virulence. Hindsight, together with the chemical knowledge of liver function of to-day, leads one to believe that the rôle infection played in the outcome was over-emphasized, and recent results of operations in the presence of acute infections seem to bear this out. In the presence of a normal metabolism delay in operating upon patients with acute cholecystitis or cholangitis is not necessary, and chemical changes in the circulating tissues of the body indicate it to be injurious.

Careful consideration of the specific factors in the preparation and after-care of individuals with gall-duct disease will be the means toward a further reduction in the mortality of the operative period. There are certain definite facts to be determined before and after operation which will designate the course of action in preparing the individual for so strenuous a period, maintaining a supply of suitable raw products of metabolism, and avoiding the dangers from the disordered system of liver metabolism. The chemical labora-

tory is a necessary constituent of every hospital, and in this instance, determinations made are of great assistance to the surgeon in the care of the patient and in increasing the knowledge of liver metabolism

Acidosis—Changes in metabolism and the occurrence of an acidosis are seldom due to destruction of liver substance and loss of function but occur from the disturbance in food intake due to the secondary effect of the diseased gall-bladder upon the stomach. In the acute gall-bladder vomiting of food occurs repeatedly during the course of the infection. After twenty-four hours the reserve supply of glycogen, which may have been normal, has been used up and unless carbohydrate is furnished in some form an acidosis surely occurs. By the aid of blood examinations the presence and extent of acidosis may be determined and corrected. Before operating upon a patient, acutely ill for thirty-six hours, the CO_2 combining power should be determined. When it is found to be below forty, measures for relief should be instituted and the operation delayed. A mild acidosis of this type can be corrected by the administration subcutaneously of 1500 cc of glucose 3 per cent and normal saline. To operate upon a patient with a CO_2 of forty is perfectly safe if it remained forty, but in every instance, following the trauma and anæsthetic there will be a further reduction which makes the after-care more difficult. A CO_2 of thirty should be corrected by the administration subcutaneously of 1000 cc glucose 3 per cent in normal saline, intravenously 1000 cc of 3 per cent glucose and by rectum 10 per cent in ounces six, every four hours. At the end of six hours another CO_2 should be done and if the rise has not been to forty-five or above, the administration should be repeated. Instances of CO_2 below thirty will require in addition to the glucose and chloride, soda bicarbonate 1 per cent added to the intravenous solution and 2 per cent to the rectal solution.

Soda bicarbonate in more concentrated solution or more than ten grams should never be given before taking the CO_2 . If the acidosis does not respond the Ph should be done before increasing the amount.

Glucose in concentrated solutions of 5 and 10 per cent is a marked diuretic producing an increase in viscosity of the blood. Also the glucose is lost by way of the kidneys when given in concentrated solutions. When time permits or the amount desired be moderate the subcutaneous administration of 3 per cent solutions is the method of choice.

In chronic gall-bladder disease the intake of carbohydrate is not as a rule interfered with. The fats are the disturbing element of the food and such patients come to operation well prepared for the acute operative metabolic emergency.

In external gall fistula of long standing the metabolism varies. The drainage of bile salts does not produce a constant acidosis and in these patients preparation should be controlled by chemical analysis of the blood. No measures for relief of an acidosis should be employed until it has been determined to be present.

Without chemical analysis of the blood, no patient should have soda bicar-

THE GALL-BLADDER PATIENT

bonate intravenously Large amounts of acetone and diacetic acid in the urine may occur in patients with an alkalosis When acetone and diacetic acid appear in the urine and the patient presents other symptoms of acidosis,

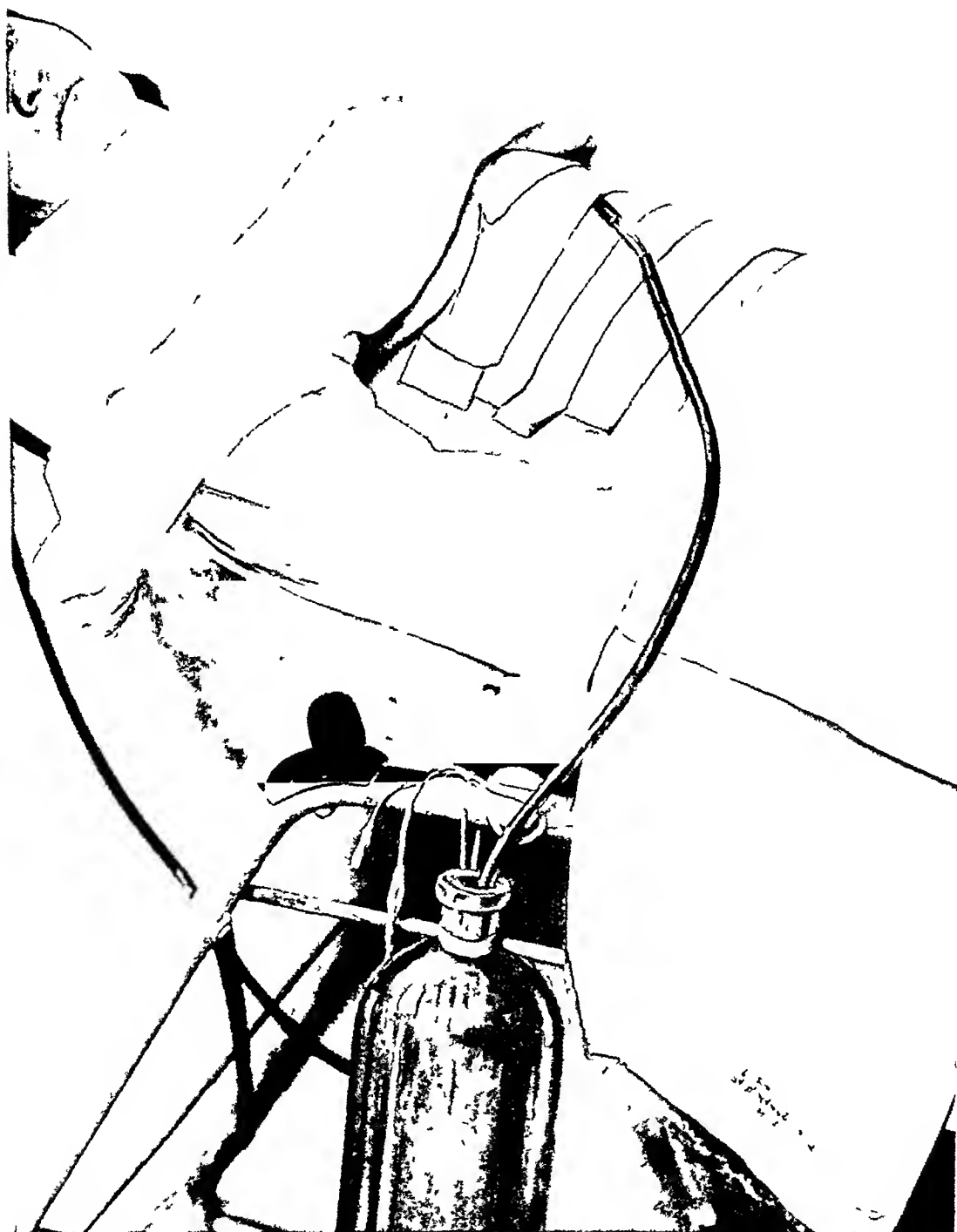


FIG 1

glucose and normal saline solution should be used until the urine is free of these incomplete products of fat metabolism When the patient has starved for thirty-six hours and urinalysis cannot be had, normal saline in amounts consistent with the period of starvation, condition of the heart and general

appearance of the patient is indicated. Periods of starvation over thirty-six hours in a patient with a history of diabetes should have glucose added in 3 per cent amounts to the saline solution. To give a patient with acidosis and a high blood sugar concentrated solutions of glucose causes a depletion of body fluids in excess of the amounts introduced, and as these patients run a high viscosity they are in danger of coma following further depletion of fluid from the diuretic action of the glucose.

Alkalosis —A state of alkalosis existing even in mild form before operation is rarely encountered. Only in those patients with an accompanying ulcer, usually duodenal in type, who have developed the soda bicarbonate habit is it apt to be present. In such individuals the taking of soda bicarbonate should be discontinued one week before operation in chronic disease, and in the acute, a chemical blood analysis made. In the latter instance a CO_2 above seventy-five should cause the operation to be postponed in all but those with ruptured viscus or extremely high temperature with chills, indicating a severe cholangitis. When the operation can be delayed the patient should have dilute HCl minims fifteen in water, ounces six, every three hours by mouth, and dilute HCl minims twenty in water, ounces six, every six hours by rectum, and the subcutaneous administration of 3 per cent glucose in normal saline 1500 c c in twenty-four hours should be used. In extreme instances of the CO_2 being above eighty-five operation is fatal unless vigorous treatment be instituted. Unusual instances of this sort are always discovered post-operatively and will be discussed later.

Jaundice —An objective symptom was as much a problem during the stone age as it is to-day. However, the control of the bleeding which occurs in those jaundiced from obstruction to the common bile ducts has been completely and simply carried out during the present period by means of the intravenous use of calcium chloride. During the second period of gall-duct surgery, blood transfusion was used for this purpose and it was successful. Blood transfusion, however, is expensive and is not warranted for the control of bleeding alone. In debilitated patients who also have an increase in clotting time, whole blood remains the best means of preventing or controlling hemorrhage. Calcium chloride which is put up in convenient ampules, in 10 per cent solution should be administered intravenously in those having a clotting time of over seven minutes, 10 c c given every six hours until the clotting time has been reduced to normal or for three injections.

Post-operative Feedings —In all instances of operations outside the gastrointestinal tract feedings should be resumed after eighteen hours. In patients with simple cholecystectomy, fluid as tap water should be resumed after six hours in amounts sufficient to satisfy thirst. Food in the form of gruels, dry toast, cooked fruits and sugar dissolved in drinks of tea, orange phosphate and pineapple phosphate should be insisted upon after eighteen hours. No acids, either as orange, grape or lemon juice should be allowed, neither ice water nor cracked ice.

In the acute case fluids by mouth will not be tolerated well before twelve

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hours, and retention enemata of water ounces six with glucose ounces one should be given every four hours during the first day. Then unless there are evident signs of a spreading peritonitis the feedings of starch and sugar by mouth should be insisted upon. Gaseous distention, if not due to operative trauma or peritonitis is best relieved on the second day by feedings.

Position—In the simple cholecystectomy any posture the patient may prefer is permissible. When drainage of the common duct or abdominal drainage of an acute infection is present the sitting posture of thirty-five degrees should be used to promote drainage and prevent subphrenic collections of bile or purulent material.

Pain—There is one characteristic type, spasmodic, breath taking and alarming. Soon after regaining consciousness, the patient complains at intervals of a spasm which grips the epigastric region and often is referred to the back and shoulder. In all instances

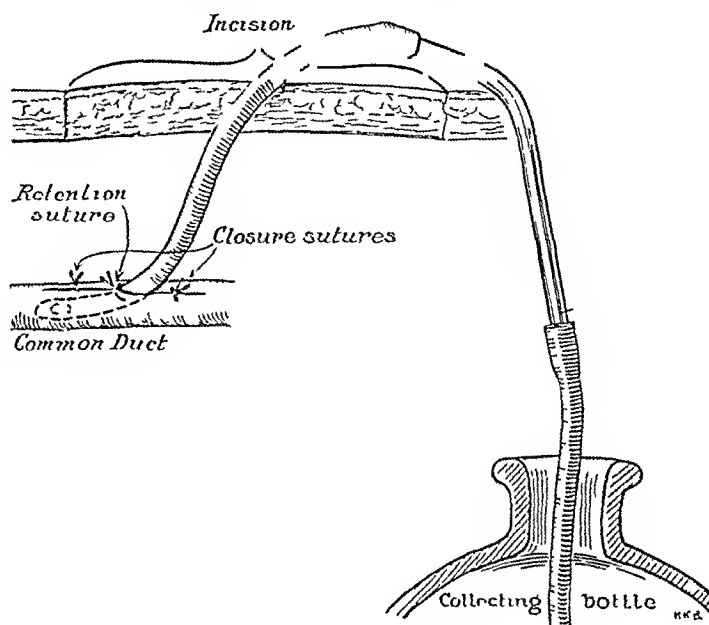


FIG 2

of this sort, I have noted later drainage from the wound of bile or broken down blood-clot. It is not caused by lack of drainage of the common duct for patients with severed common duct complain, if at all, of a continuous pressure somewhere in the upper abdomen. Morphine in large amounts will not entirely relieve the suffering and will not stop the spasm. If due to intra-abdominal drainage of bile the drainage should be loosened or the sutures adjoining the drain cut. If due to intra-abdominal hemorrhage, morphine in large doses to relieve the pain which will persist for eighteen hours usually suffices and at the end of five days broken down blood clot will be extruded to explain the cause of the spasm and pain. There is an expiratory grunt similar to that accompanying pleurisy and explanation of the pain may be that the retained material is forced up under the diaphragm.

Hemorrhage—There are two types peculiar to disease of the liver and ducts. First, the ooze from the fine capillaries due to changes in blood coagulation. At present and only in acute instances will this form be encountered for the preliminary use of calcium chloride and blood transfusion have eliminated this dreaded type of bleeding. When in the acute or neglected instances of its occurrence, calcium chloride should be administered in 10 cc of 10 per cent intravenously every four hours until the coagulation period returns to normal. Should this means fail and if there has been considerable

blood loss to hæmoglobin of sixty or below, blood transfusion should be resorted to

Hæmorrhage from within the common duct with the ulceration of a liver sinus in ulcerative cholangitis may be sudden and profuse. Morphine in large doses and transfusion to replace the blood loss are indicated. This type of hæmorrhage is rare and when it occurs is usually the terminal stage of a prolonged liver infection.

Common Duct Drainage—Drainage tubes introduced into the common duct for external drainage are usually sewn in place. Instances of broken

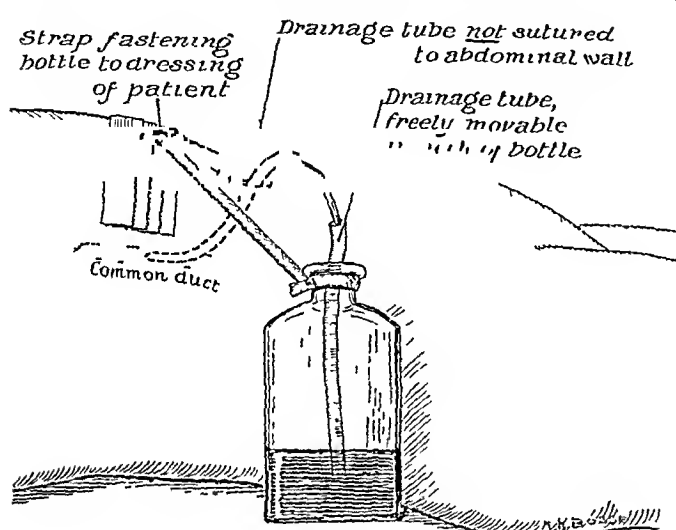


FIG 3

tubes with a portion left in the duct necessitating choledochotomy have been reported. Any pull exerted upon the common duct tube is to be very carefully avoided. Extending the tube by means of a connecting link which carries the bile to a bottle fixed to the bed railing is a common practice (Fig 1)

As this tube enters the bottle, usually one with a narrow neck, at a perpendicular plane, it will bind and catch if withdrawn at an angle. In turning the patient the tube is pulled upon at an angle which often results in binding at the bottle neck, with pull being put upon the other end which is firmly sutured to the common duct (Fig 2)

The stitch in the common duct may tear out leaving a transverse tear which may later result in an obstructing cicatrix, or the tube may break at its weakest point up to the stitch and if the weakest point, as it usually is, be at the stitch, the tube will come away leaving a portion in the common duct. To avoid the possibility of breaking off the tube in this way, Dr John F Erdmann has devised the plan presented. The drainage tube is connected by means of an angle glass tube with a section of tube long enough to extend to the level of the bed. Around this second length of tubing, and not attached to it in any way, an ordinary eight ounce specimen bottle is placed. And the bottle is attached to the adhesive dressing, or tie straps, by looping one end of a length of tape around the neck of the bottle and pinning the other (Figs 3 and 4)

This arrangement prevents traction being put upon the tube, and also kinking of the tube, which may occur when long tubes are used. Turning the patient is facilitated by this means, in that the bottle, which carries the tube, is merely raised and carried to the opposite side by the attendant or by

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the patient Little care is needed to prevent spilling the contents of the bottle, when the tape is made only long enough to permit the bottle to rest upright on the bed (Fig 4)

Acidosis—Post-operative acidosis when mild usually presents on the second day It may be from either intensive preliminary catharsis, starvation for two or three days in preparation for operation or starvation because of the pain and nausea attendant upon the passage of stone Obese women



FIG 4

are most often affected and in such apparently well-nourished individuals it is at first a surprise The storage of sugar is not greater in the obese than in the thin individuals and need of preparation of carbohydrate is less apt to be apparent in the fat than in the lean The appearance is characteristic In the afternoon of the second day the patient becomes restless, face flushed, complaining of generalized pain and of feeling miserable, desires cracked ice, will take ice water or orange juice in large amounts Vomiting of stomach and duodenal contents occurs, distention is marked and not relieved by enemata, the tongue is dry and parched, lips covered with scaling epithelium There is a rise in pulse, temperature and respiration The pulse is good and the temperature seldom rises above 103 degrees, the respiration is fast

and shallow Orange juice is the desire of the majority and the most injurious drink in that the hyperacidity and gastric distress are increased Treatment of this type does not require chemical blood analysis Sugar and water are required Administration differs, by rectum normal saline ounces six and glucose ounces one every three hours is the mainstay—water of a moderate temperature by mouth in regulated amounts of ounces three every hour No ice either externally or internally should be allowed After twelve hours gruel, dry toast, tea with sugar and vegetable broth thickened with starch must be insisted upon A firm binder for distention after a medicated enema with the frequent use of the rectal tube For restlessness which is due to lack of fluid, besides the fluid, codein and bromide suffice to quiet the patient until the fluid loss has been replaced No soda bicarbonate either administered to be retained nor in auto lavage solution should be permitted For while the clinical difference between acidosis and alkalosis is fairly well established, some patients with typical symptoms of acidosis may in reality be in the state of early alkalosis In which case glucose, normal saline and water are indicated and of general value, while soda bicarbonate is fatal

The severe type of acidosis occurs in acute infections of long standing and usually in company with a post-operative spreading peritonitis The picture is different There is a general expression of horror which is characteristic, the eyes are sunken, white showing, rimmed with dark moist lids The mouth is open, sores covered teeth appear before a tongue dry, parched and bile-stained over which the moist acetone breath is drawn rapidly back and forth in quick gasps which are frequently augmented by deep sighs ending in moans of despair much more impressive than those arising from acute localized pain The skin is moist, dusky and lifeless The pulse races in small volume and is the true thready variety Generally there is, next to that from hemorrhage, the most impressive type of restlessness, both due to an hunger This is the danger stage and one requiring laboratory aid for its relief Blood analysis to determine the CO_2 combining power, urea, chloride and sugar is imperative Preliminary measures are those indicated in all instances of fluid loss, namely glucose, water and sodium chloride Subcutaneous administration of glucose 3 per cent in normal saline 1000 c c, intravenous medication except in specific amounts is not indicated nor well tolerated by these patients After determining the CO_2 which should not require more than one hour, should it be below thirty, intravenous glucose 3 per cent, soda bicarbonate 1 per cent solution 1000 c c should be administered In a quick response within one hour the patient should show improvement and will if the peritonitis be not too extensive or virulent in character Repeating the subcutaneous glucose in normal saline in eight hours will restore the patient to the point where retention enemata of glucose and normal saline will suffice Carbohydrate by mouth should be withheld for a period of eight hours, after last vomiting Beginning with tea and sugar and increasing to gruel, toast and vegetable broths No patient with an acidosis and a CO_2 combining power

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of over fifteen in the absence of heart or kidney disease should be considered hopeless or even a difficult problem

Blood analysis repeated every twelve hours is a necessity in the well executed treatment. To proceed blindly to give soda bicarbonate as was done five years ago will in many instances convert the picture from a simple acidosis into an irreparable alkalosis

Alkalosis—Unfortunately for the patient and one in attendance, alkalosis

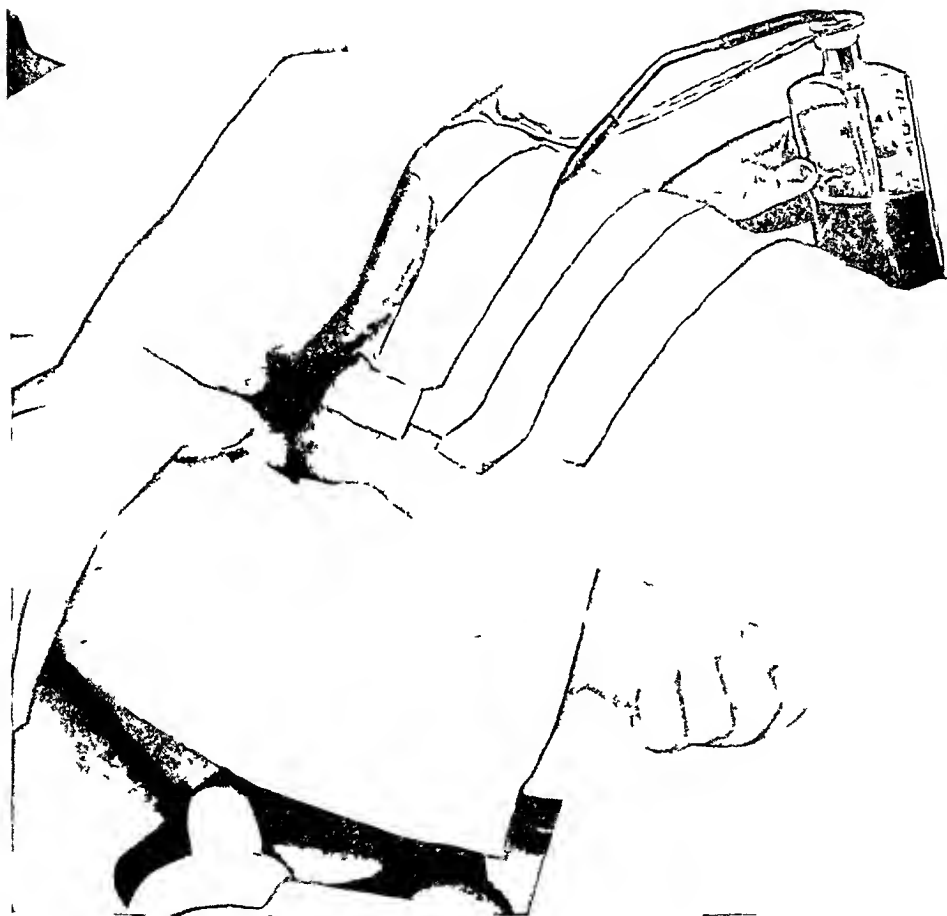


FIG 5

is generally discovered late. Of subjective symptoms there are none and the objective cannot be divided into early and late periods. One should be on constant guard and then late discovery will be the rule with the present knowledge on this subject. Prodromal symptoms are not characteristic but in the presence of biliary drainage, a complaint of weakness, lethargy and a rise in temperature and scant drainage of precipitated bile, a CO_2 determination should be done. In many instances normal findings will be followed by a good night's sleep and a bright and cheerful patient in the morning. In too many a quiet night, rise of temperature, cessation of biliary drainage and a stuporous patient ensue. So the danger point is reached and past before one is well aware of anything alarming.

The well developed alkalosis transforms an individual from a state of quiet composure to one of quiet tension or twitching somnolence. The facial expression remains normal for deep slumber, eyes and mouth closed, slow, sonorous respiration, the extremities are held in tonic spasm with the knees flexed upon the trunk. The tongue is moist and the eyes rolled up, pupils normal. There may be a carpo pedal spasm, however, many die without developing the typical symptom. There may be twitching or a coarse tremor of the extremities. The skin feels normal, and only as a terminal sign do the temperature and pulse rate go up to very high levels, twelve to eighteen hours before death.

Treatment presents a peculiarity noted in these patients in that Hcl will do more toward recovery than in alkalosis of other conditions. The most severe type may occur in individuals who have not vomited and in those without drainage of bile. There is no rule of occurrence but the dependable relief is in the administration of Hcl in large amounts. By mouth fifteen minims in water ounces six every two hours. By rectum twenty minims in water ounces six every three hours. In severe instances calcium chloride by vein 30 c.c. of 10 per cent solution in divided doses can be used. Large infusions of normal saline and glucose are contra-indicated from experience and there is not the drop in chlorides of the blood as noted in alkalosis of intestinal obstruction.

Residual Infections—Foci of infections have been ridden extensively through the literature on all subjects. But assuredly there is a permanent place in the after-care of gall-bladder patients for this subject. Infected teeth, tonsils, nasal sinuses and within the abdomen diseased adnexa, uterus, cervix and colitis are a cause for recurrent biliary explosions. Following a flare-up in any of the above mentioned foci there occurs, a pseudo gall-bladder attack as characteristic of a primary gall-bladder involvement as if the gall-bladder were present. Relief from recessions of this sort does not come from food control but from radical attention to the existing focus of infection.

SOME RESULTS OF SURGERY OF THE BILIARY TRACT *

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THIS paper represents a study of 136 cases of biliary tract disease. The cases are all personal ones, most of which were operated upon while on Service C of the University of Pennsylvania Hospital. The review includes 33 operations for acute gall-bladder disease with 2 deaths, 78 operations for chronic gall-bladder disease with 2 deaths, 21 operations for biliary disease with obstructive jaundice with 4 deaths, and 2 operations for carcinoma of the gall-bladder with 1 death, and 2 cases with associated duodenal ulcer with 1 death. A follow-up study has been made and a response has been obtained from 94 per cent of the patients.

In an effort to clarify or confirm the existing ideas concerning the pathogenesis of gall-bladder disease, a study was made with respect to sex, age, and race, obesity and the relation of the disease to pregnancy.

Race and Sex—Of the 134 patients with gall-bladder disease 83 were females and 17 were males. There are 3 negroes in this series. This relative infrequency of biliary disease has been noted by many authors. It would seem, therefore, that comparative studies between the white and black races might do much toward coming to a final definite decision with regard to the etiology of gall-bladder disease.

Age—	Less than 20	20-29	30-39	40-49	50-59	60-69	70+
No. of cases	1	12	33	37	30	12	3

The group between twenty and forty years, usually considered below the gall-bladder age, included 36.5 per cent of our patients. Sixty-five per cent of the cases in females came to operation during the child-bearing period.

Obesity—A note designating the patient as obese was found in 76 cases. In all but 2 of the cases occurring in males, obesity was found.

Relation to Pregnancy—Some interesting observations were made of the relation of cholelithiasis to pregnancy. The data was not complete in all cases, but using that which was available it was found that 74 of the 111 female patients had passed through one or more pregnancies. Twenty-two of these noted that their attacks occurred or recurred during or shortly after a pregnancy. One patient gave a history of having an attack of gall-stone colic follow each one of five deliveries. A large majority of our cases in women between twenty and thirty occurred during or immediately following the first or second pregnancy.

With these factors in mind, we may say, then, that cholelithiasis is a disease primarily of women, that it occurs most often in the obese, and that it

* Read before the Philadelphia Academy of Surgery, December 6, 1926.

bears a definite relation to pregnancy. We believe then that gall-stone formation is not primarily a phenomenon of infection, but that it is a metabolic phenomenon brought about by an effort on the part of the body to excrete an increase of cholesterol from the blood. Any condition which causes an increase of cholesterol in the blood over a considerable period of time would predispose to gall-stone formation. It has long been known that during pregnancy there is a distinct hypercholesteræmia, and, since the blood cholesterol parallels very closely the blood fats, it is not hard to believe that a hypercholesteræmia had occurred in a patient who has covered her body with a thick layer of fat.

No doubt infection plays a very prominent part in gall-bladder disease, but we believe its rôle is late in the process. The operations performed on young women disclosed gall-bladders which were normal to inspection and to palpation. They contained single or multiple stones which were soft, round, and slightly lobulated in appearance. They were composed of almost pure cholesterol. The bile, which was cultured in several cases, was sterile. These cases were looked upon as the earliest form of gall-bladder disease.

The patients showing evidence of infection were found in the older patients with thickened gall-bladders and faceted stones, indicating a disease which had probably been present for years. It is the long-standing irritation of the gall-bladder wall by the presence of stones and the trauma caused by distention when a stone obstructs its outlet which open the way for infection by bacteria which are constantly being excreted through the bile from the liver or which come to it from the blood stream.

Principles of Treatment—Few, if any, cases of gall-bladder disease need be considered surgical emergencies, and the disease is serious enough to demand thorough pre-operative study and treatment. The only exceptions to this dictum may be found in the acute group and even among this number are many which would be benefited rather than harmed by a day or two of observation.

The pre-operative treatment may be divided into two parts. First, measures for the relief of pain, of which hot poultices of flaxseed applied to the whole abdomen, continuously, seem the most efficacious. If necessary, morphine may be given hypodermically in addition. The patient should be given nothing by mouth. By this means the vomiting is controlled and the duration of the attack decreased.

Second, measures to reduce the risk of operation. Fluids, preferably 5 to 10 per cent glucose solution, are given by enteroclysis. The pre-operative administration of carbohydrates is probably the best insurance against post-operative hepatic complications. If the patient shows jaundice, special precautions are necessary which will be discussed under the head of biliary obstruction.

Pre-operative study in the doubtful or chronic cases includes an X-ray examination. Of the patients examined before the Graham technic was

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adopted, 8 showed evidence of gall-bladder disease, while 18 gave no abdominal findings in a simple examination of the upper right abdomen

Since using the Graham technic, a diagnosis of gall-bladder disease was verified in 12 cases, but in 3 others, cases in which a negative diagnosis was received, definite pathology was found in the gall-bladder region, an error of 20 per cent. In all of these cases the oral method of giving the dye was used

Our opinion is, that an X-ray examination is not necessary in all cases of gall-bladder disease. It is more useful in the thinner patients who border somewhat on the ulcer type and in all cases in which the diagnosis is doubtful. The X-ray readings are correct in competent hands in about 80 per cent of the cases. The patients the least likely to give a correct reading are the younger women in whom small stones have formed, but in whom the gall-bladder function is still good

Operation—1 *Anæsthetics*—Operations on the biliary tract demand more care in the choice of anæsthesia than probably any group of abdominal operation. Gradually the tendency has been to change from the more shocking inhalation anæsthetics to the local and regional anæsthesia induced by novocaine, adding if necessary gas analgesia

Anæsthetics

Ether—43 cases with 4 deaths

Nitrous oxide and ether—48 cases with 3 deaths

Local and gas—15 cases with 2 deaths

Gas—1 case—no deaths

Local—7 cases—no deaths

Splanchnic—18 cases—no deaths

Splanchnic and gas—4 cases—no deaths

By far the most satisfactory anæsthetic in our experience is obtained by blocking the splanchnic nerves posteriorly as suggested by Kappis. There must be a local infiltration of the abdominal wall in addition, with a block of the intercostal nerves at the costal margin. After the peritoneum is opened a wall of local anæsthesia is placed just beneath the parietal peritoneum, using the finger in the abdominal cavity as a guide. It is usually necessary to place a small amount of novocaine in the round ligament and at times the anæsthesia is not complete until the gastro-hepatic omentum near to the pylorus and about the cystic duct is infiltrated

The induction of this anæsthesia is somewhat time-consuming but is not painful or irritating except to the very nervous patient. It is successful alone in about 82 per cent of the cases. In the others a light gas anæsthesia is all that is necessary. Under the splanchnic block it is possible to explore the abdomen, except the pelvis, and often the appendix can be pulled into the wound and removed without additional anæsthesia

2 *Incision*—The incision used in most of the earlier cases, and in all the cases in which the diagnosis was not certain, was one through the upper

right rectus muscle. There were 56 patients in whom this incision was used and they have all healed without evidence of hernia. The difficulty of exposure and of closure in many cases, and the frequency with which serum collected in the wound, led to a change.

In practically all of our later cases, a transverse incision was used extending from the rib margin nearly to the midline, at a level about two fingers' breadth above the umbilicus. After cutting through skin and subcutaneous fat, the obliques and transversalis are divided in the line of their fibres outward, beginning at the edge of the rectus sheath. The peritoneum is then opened and with the finger in the abdomen, two rows of interrupted sutures are placed, catching the rectus with its anterior and posterior sheaths. The rectus is then divided between the sutures to within three-quarters of an inch of its mesial edge. This incision usually gives sufficient exposure for cases of acute cholecystitis in which a cholecystostomy is to be performed. It may be readily enlarged by carrying the incision upward through the rectus. This is usually necessary in order to perform a cholecystectomy or an operation on the common duct.

The transverse incision was used thirty-two times and of this number there was one incisional hernia, and one patient who showed a slight pouting at the site of a cholecystostomy opening. There were 35 cases in which the incision was enlarged upward through the rectus, all of whom have healed without hernia.

This incision has the advantage of giving much better exposure than can be obtained by the right rectus incision alone. It is also very easy to close.

3 *Special Apparatus*—In those cases in which cholecystostomy is to be performed, some instruments have been devised which greatly facilitate the operator, and which decrease considerably the operative trauma.

A sharp, round-pointed aspirating trocar, with water pump suction, devised by the junior author, is used to rapidly evacuate the fluid in the gall-bladder without soiling the wound, later a blunt-pointed aspirator may be substituted to completely empty the organ.

When the gall-bladder is empty of fluid and stones, the senior author's cholecystoscope may be used to view the inside of the organ. This instrument was used in fifteen cases. In that number there were four cases in which stones were discovered in the gall-bladder after a thorough search with scoop and finger had failed to show further calculi. An incomplete operation was discovered then in 26 per cent of the cases in which the scope was used. We believe that from this group come most of the patients who have a return of symptoms following cholecystectomy.

Post-operative Treatment—The patients are placed in semi-Fowler position and are given enteroclysis routinely, a pint each of tap water with tincture of digitalis two fluid drachms, glucose 5 per cent and sodium bicarbonate 2.5 per cent in order named. Since the use of local anæsthesia, fluid may frequently be given by mouth, after the first or second pint of enteroclysis.

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All patients are encouraged to suck fruit lozenges or to use chewing gum, in an endeavor to keep the mouth moist and minimize the occurrence of parotitis.

Carbohydrate foods have proven the most helpful in these cases because of their rapid absorption and easy utilization by the body. Glucose with insulin intravenously we have found to be the best treatment for those cases of "liver deficiency" which appear a considerable time after operation.

The patient is instructed to take ten deep inspirations per hour. This has a tendency to clear the lungs and minimize pulmonary complications.

After the first week the cholecystostomy and common duct tubes are clamped for an hour after each meal, and the interval between clampings is decreased gradually so that toward the end of the second week the tubes may be clamped all the time. By thus allowing the bile to flow into the intestine during the periods of digestion, we have been able to overcome the nausea that frequently follows the taking of food in these cases of bile drainage.

In our cases the average time for the removal of the cholecystostomy tube was thirteen days. The choledochostomy tube, usually a T-tube, was removed from the sixteenth to the nineteenth day, *i. e.*, as soon as the tube could remain closed for several days at a time, without causing pain. No biliary fistulæ have resulted.

Hospital Days—Cholecystostomy patients usually remain in bed until the tube has been removed (fourteen days). They are discharged after they have been up and around the ward for two or three days. The average stay in the hospital for these patients was twenty days, divided as follows:

Less than 15 days	16-19 days	20-29 days	30 days +
7 cases (1 in hospital)	13 cases	25 cases	4 cases

A cholecystectomy without drainage kept the patient in the hospital an average of seventeen days in 40 cases. These were divided as follows:

Less than 15 days	16-19 days	20-29 days	30 days +
23 cases (1 in hospital)	13 cases	4 cases	3 cases

A cholecystectomy with drainage demanded an average stay in the hospital of twenty-six days in 12 cases. These were divided as follows:

Less than 15 days	16-19 days	20-29 days	30 days +
2 cases	6 cases	4 cases	3 cases

More than half the cases of cholecystostomy demand a hospital stay of more than three weeks, while a cholecystectomy closed without drainage gives a patient a 50 per cent chance of discharge in two weeks, and 85 per cent of these cases can be discharged in two and one-half weeks. A cholecystectomy case with drainage demands a longer stay in the hospital, the delay in most cases being attributed to a wound infection.

Post-operative Complications—Wound infections occurred eight times in this series, five times in a right rectus incision, once in a transverse, and twice in a right-angled incision.

Pulmonary Group—Broncho-pneumonia occurred in 4 cases, and acute bronchitis in 2. These cases were all in the group with acute cholecystitis

Lobar pneumonia—1 case with death
 Massive atelectasis—1 case with death
 Pulmonary embolism—1 case
 Empyema thoracis—1 case following pericystic abscess

Cardio-vascular group

Chronic myocarditis—1 case with death
 Femoral phlebitis—1 case
 Hæmiplegia—1 case

Early hepatic insufficiency (liver shock, or toxic liver) as characterized by high temperature, pulse and respiration, low blood-pressure, cold moist skin, etc., occurred in six instances, one or two days following operation. Death followed in each case.

Late hepatic insufficiency occurred in 2 cases two to three weeks after operation. These cases are usually ones with common duct drainage and are characterized by lassitude, low blood-pressure, subnormal temperature, anorexia, and vomiting. One of these patients died.

Liver abscess—*echmococcus*—1 case
 Acute pancreatitis—2 cases with 1 death

The most serious of these complications fall in the group of so-called hepatic insufficiency. Our knowledge of the cause of these conditions is meagre, hence we know very little concerning their treatment.

Analysis of the Cases with Follow-up Results—1. Acute Cholecystitis—This group includes all the acute and subacute cases of gall-bladder disease, as evidenced by elevation of temperature, leucocytosis, and acute tenderness and rigidity in the upper right abdominal quadrant. In 14 of the 28 cases a mass was palpable in the upper right quadrant.

The choice of operation in these cases depends largely upon the conditions found at operation. When the gall-bladder is tense and thickened, the gastro-hepatic omentum œdematous and the head of the pancreas indurated, by far the safer operation is a cholecystostomy. Cholecystectomy should be performed only where drainage of the gall-bladder can not be accomplished because of gangrene or for other reasons apparent at the time of operation.

Summary of the Follow-up Results for Acute Cholecystitis

Operation	No symptoms	Improved	Unimproved	Operative death
Cholecystectomy				
10	9			1
Cholecystostomy				
21	16	4		1
Cholecystostomy with drainage of pancreas				
2	2			

Of the 4 patients listed as improved, one has had one attack of pain and vomiting of two days' duration, one indigestion, one has a slight hernia at the

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site of the drainage tube, and one returned with a pericystic abscess followed by an empyema thoracis

The mortality in this group was 6.06 per cent, with cholecystectomy 10 per cent, and with cholecystostomy 4.3 per cent

Analysis of Cases that Died Following Operation for Acute Cholecystitis

Case	Age	Duration of acute symptoms	Operation	Post operative days	Cause of death	Necropsy findings
1	45	2 days	Cholecystectomy	1/6	Pulmonary embolism	Refused-obesity
2	65	20 days	Cholecystostomy Appendectomy	1	Acute hepatic insuf	Hepatic cirrhosis Chr myocarditis Chr hypertrophic prostatitis Extreme obesity

2 *Chronic Gall-bladder Disease*—This group comprised 78 cases. There were two cases in which an associated duodenal ulcer was found and for which a posterior gastro-jejunostomy was performed in addition to the removal of the gall-bladder. In 22 of these cases an appendectomy was also performed.

The choice of operation in this group is for a cholecystectomy, if it can be performed with safety to the patient. The operation should not be attempted if

- (1) A very fat abdominal wall prohibits good exposure
- (2) The patient is not a good operative risk because of jaundice, pancreatitis, cardiac or renal disease, age, respiratory infection, etc
- (3) The assisting and nursing staff are strange or inadequate
- (4) The anatomical difficulties found at operation are extraordinary

In all these cases it is safer to drain the gall-bladder, *i e*, in case of doubt do a cholecystostomy.

Summary of the Follow-up Results for Chronic Cholecystitis

Operation	No symptoms	Improved	Un-improved	Operative mortality	No report
Cholecystectomy					
49	37	2	1	2	6 1*
Cholecystectomy					
Posterior gastro-enterostomy					
2	1			1	
Cholecystostomy					
27	18	6	1		1 1*
Cholecystotomy					
2	2				

* In hospital

Of the patients in which cholecystectomy was performed two patients were not entirely well. They complained of "bilious attacks," distention and belching after eating. They had no pain. One patient in whom the pre-operative diagnosis was not clear complains of the same symptoms as before operation. She is a thin, neurotic individual and a regular attendant at the

medical dispensary Of the 40 patients from whom follow-up reports have been obtained, 35 are entirely relieved—87.5 per cent cures

The operative mortality was 4 per cent in cholecystectomy without associated disease In the cholecystostomy cases without associated disease the mortality was nil, and the combined mortality 2.5 per cent

There were 6 cases listed as improved following cholecystostomy Of these two were free from pain, and complained only of belching and distention Three patients had a return of pain, in one or more attacks, and a cholecystectomy was later performed on one of these One patient has discharged several faceted stones from her drainage tract There were no biliary fistulae The patient listed as unimproved later developed carcinoma of the gall-bladder

Of the 25 patients followed, 18, or 72 per cent, are completely relieved by cholecystostomy There were no deaths in the 26 cases

This low morbidity figure is probably not quite a fair one in that many of these cases were operated upon but a short time ago (since September, 1922)

Analysis of the Mortality Following Operation for Chronic Gall-Bladder Disease

Case	Age	Duration of symptoms	Previous operation	Operation	Post-operative days	Cause of death	Associated conditions
1	41	3½ yrs	Cholecystostomy	Cholecystectomy	1	Acute hepatic insufficiency	Mitral stenosis Incisional post-neg
2	50	1 yr	None	Cholecystectomy and Appendectomy	2	Acute hepatic insufficiency	Incisional post-neg
3	40	2 yrs	None	Cholecystectomy Posterior gastro-enterostomy	4	Acute pancreatitis	Abdomen showed fat necrosis

Combining groups 1 and 2, the mortality with cholecystectomy was 5 per cent in 58 cases, and with cholecystostomy alone it was 2 per cent In other words, in the 111 cases of gall-bladder disease, both acute and chronic, without associated lesions, the operative mortality was 3.6 per cent, adding the one death in the two cases with associated duodenal ulcer makes a mortality of 4.4 per cent

3 *Chronic Gall-bladder Disease with Common Duct Obstruction*—The patients in whom there is a biliary obstruction are among the poorest of surgical risks Their pre-operative preparation should be as thorough and complete as is that practiced for patients with toxic goitre It should include an estimate of bile pigments in the blood serum, urine and faeces in order to accurately follow the course of the jaundice after operation The clotting time should be estimated and calcium chloride given intravenously as a routine measure It is well to have a donor ready and cross agglutinated with the patient before operation

The fluid intake should be kept high, giving hypodermoclysis if necessary

SOME RESULTS OF SURGERY OF THE BILIARY TRACT

Carbohydrate ingestion should be encouraged, by mouth, in solution, in the fluids given by enteroclysis or hypodermoclysis and even intravenously

Splanchnic and infiltration anæsthesia is never more useful than in this group of cases. Ether seems to act poorly in these patients with damaged livers. Under splanchnic block a cholecystectomy and a choledochostomy may be performed, yet the temperature and pulse be within the normal range when the patient is returned to the ward.

Summary of Follow-up Results Following Operation for Chronic Cholecystitis with Biliary Obstruction

Operation	No symptoms	Operative mortality
Cholecystectomy with common duct drainage		
11	10	1
Cholecystostomy with common duct drainage		
8	5	3
Choledochostomy		
2	1	1

All of the patients who lived were completely relieved. The operative mortality was 23 per cent.

Analysis of Mortality Following Operation for Chronic Cholecystitis with Biliary Obstruction

Case	Age	Duration of symptoms	Duration of jaundice	Operation	Position of stones	Post-operative days	Cause of death	Associated conditions
1	44	10 yrs	Slight Intermittent	C oostomy C dochostomy Appendectomy	Common duct above duodenum	5	Lobar pneumonia	Increase of jaundice Obesity
2	37	5 yrs	7 wks	C ectomy C dochostomy	Common duct above duodenum	6	Massive atelectasis	None Obesity
3	54	1 yr	7 wks	C oostomy C dochostomy	None Stricture at junction of cystic and hepatic duct	14	Hepatic insufficiency	Obesity
4	27	9 yrs	2 wks	C oostomy C dochostomy	Behind duodenum	1	Acute hepatic insufficiency	Necropsy showed hepatic cirrhosis
5	50	7 yrs	1 wk	C dochostomy	Behind duodenum	1	Acute hepatic insufficiency	Necropsy showed hepatic cirrhosis

There is little choice in the operation in these cases. The common duct is always opened and the obstruction relieved by the removal of the stones. To

make sure that the duct is patulous a small French catheter is usually passed through the sphincter into the duodenum. The common duct is usually drained by the use of a T-tube. If conditions allow, the gall-bladder is emptied of stones and a tube sutured in it. In these jaundiced cases the gall-bladder is not removed if it can be used for drainage. In some cases the gall-bladder shows so much damage that it must be removed and in other cases it may be so atrophic that it can be allowed to remain untouched. The least that can be done to relieve the immediate emergency in these cases offers the best chance for recovery.

4 *Carcinoma of the Gall-bladder*—There were two cases in this group, an incidence of 1.4 per cent for the 136 patients. Both of the patients were males, one fifty-four and the other sixty-one years of age. A history was obtained of upper right-sided pain of rather short duration and a mass could be palpated in the right hypochondrium in each case.

In one patient a cholecystostomy was performed without recognizing the carcinoma. Enlarged glands were noted about the cystic duct which were thought to be inflammatory. He returned one month after his discharge with complete biliary obstruction. At operation there was a mass of indurated tissue in the region of the gastro-hepatic omentum, but no evidence of common bile duct could be found. The patient died in the hospital fourteen days after operation.

The second patient was diagnosed as carcinoma of the gall-bladder before operation. A cholecystostomy was performed for the relief of pain. No attempt could be made to remove the gall-bladder because the growth had already invaded the liver. The patient died at home one month after operation.

SUMMARY

1 An analysis has been made of 136 cases of gall-bladder disease of whom 94 + per cent have been followed.

2 A theory has been advanced against the infectious origin of cholelithiasis.

3 The surgical principles used in the treatment of these cases have been enumerated.

4 Of the cases of acute cholecystitis, 89 per cent have been cured by cholecystectomy with an operative mortality of 10 per cent, by cholecystostomy, 76.4 per cent have been relieved of all symptoms, with an operative mortality of 4.3 per cent. Combined—6 per cent.

5 Of the cases of chronic cholecystitis, 87.5 per cent of the patients who had a cholecystectomy were cured with an operative mortality of 4.1 per cent, cholecystostomy resulted in no mortality and 72 per cent of the patients were relieved. Combined 2.5 per cent.

6 The operative mortality of the combined acute and chronic infections of the gall-bladder unassociated with other lesions was 3.6 per cent.

7 Of the patients operated on for biliary obstruction 77 per cent were relieved. The operative mortality was 23 per cent.

FOREIGN BODIES IN THE INTESTINE*

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OPERATION for an acute perforation of the sigmoid, produced by a pin accidentally swallowed six days previously, disclosed the fact that the head and not the point presented itself through the wall of the gut. The literature of foreign bodies in the intestine is replete with interesting and unusual cases such as this. Ingested foreign bodies, varying widely in number, size, and character, may travel through a distensible tube of comparatively small diameter, causing repeated mechanical insults to the intestinal wall without producing symptoms or permanent tissue damage. In addition, the phenomena mentioned above will be considered from the standpoint of the pathological physiology and the mechanical factors involved.

From 1915 to 1926, there have been at the Presbyterian Hospital forty-eight cases of proven foreign body in the intestine. All of them were swallowed and many different types were encountered. Most of those that could be followed were evacuated without untoward symptoms. For purposes of simplification the cases have been charted according to a definite scheme which is seen in the accompanying table.

An analysis of these cases (also seen in the graphs, Figs 1 and 2) shows the following:

ANALYSIS OF 48 CASES†

Age

Youngest patient	5 months
Oldest patient	64 years
Number of patients between	
1-5	31 = 64.7 per cent
6-10	5 = 10.3 per cent
11-20	4 = 8.3 per cent
21-65	8 = 16.7 per cent

Sex

Female	26 = 54.2 per cent
Male	22 = 45.8 per cent

Type of Foreign Body

Sharp	{ Pins	Straight pin	6	False molar with plate	2
		Bar pin	2	Tack	1
		Pin with large head	3	Nail	1
		Screws	4	Fishbone	1
		Needle	2	Chicken-bone	1
Total		23 = 47.92 per cent			

* Read before the Section on Surgery of the New York Academy of Medicine, December 3, 1926.

† The common factors for all these cases were age, sex, and type of foreign body. Thirty-one cases could be followed completely and these are analysed separately with additional constant factors.

LOUIS CARP

Dull	Coins	Penny	5	Ring	2
		Nickel	3	Pencil	1
	Closed safety pins		4	Piece of metal	1
	Toys	Whistle	2	Stomach tube	1
		Metal horse	2	Tube with radium	1
	Fruit stone, seeds	3			
Total			25 = 52.08 per cent		

ANALYSIS OF 31 CASES (WITH FOLLOW-UP)

Number of sharp foreign bodies that passed without complications—10 out of 12 = 83.3 per cent

Number of dull foreign bodies that passed without complications—15 out of 19 = 79 per cent

Total number passed—25 out of 31 = 80 per cent

INTESTINAL FOREIGN BODIES ANALYSIS OF 48 CASES

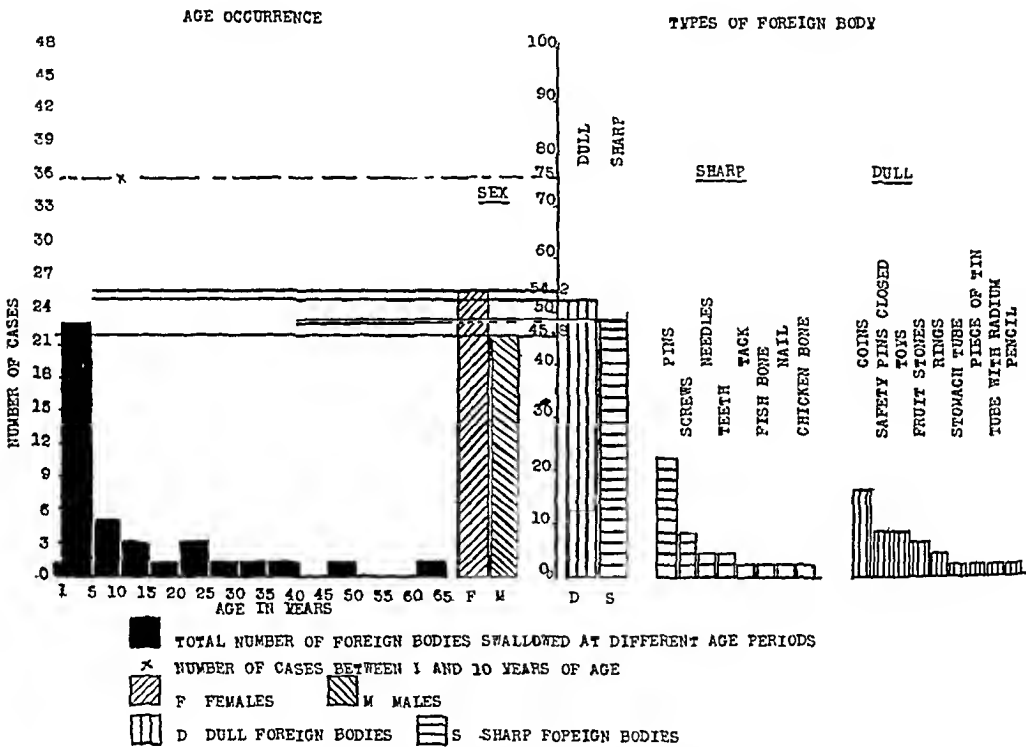


FIG 1—Foreign bodies in the intestine

Symptoms referable to those foreign bodies that were passed—4 (16 per cent) had symptoms divided between abdominal pain and vomiting

Symptoms referable to complications

- 1 Acute ileus—case died
- 2 Chronic ileus—case died
- 3 Perforation of sigmoid with peritonitis—case recovered
- 4 Acute appendicitis—case recovered
- 5 Pelvic peritoneal abscess—case recovered

Longest time that foreign body stayed in any one part of intestine

Nail in cecum—3 weeks

Shortest time in which foreign body was passed { dull—20 hours
sharp—2 days

Longest time in which foreign body was passed { dull—4 weeks
sharp—3 weeks

FOREIGN BODIES IN THE INTESTINE

Average time for passage of sharp foreign bodies—7 33 days

Average time for passage of dull foreign bodies—5 days

Average time for passage of all foreign bodies—6 17 days

35 per cent of all the cases had catharsis A little less than half of these had sharp foreign bodies None developed complications

To summarize, it appears from the foregoing analysis that

- 1 The foreign bodies were swallowed accidentally or by those who knew no better

PASSAGE OF INTESTINAL FOREIGN BODIES ANALYSIS OF 31 CASES

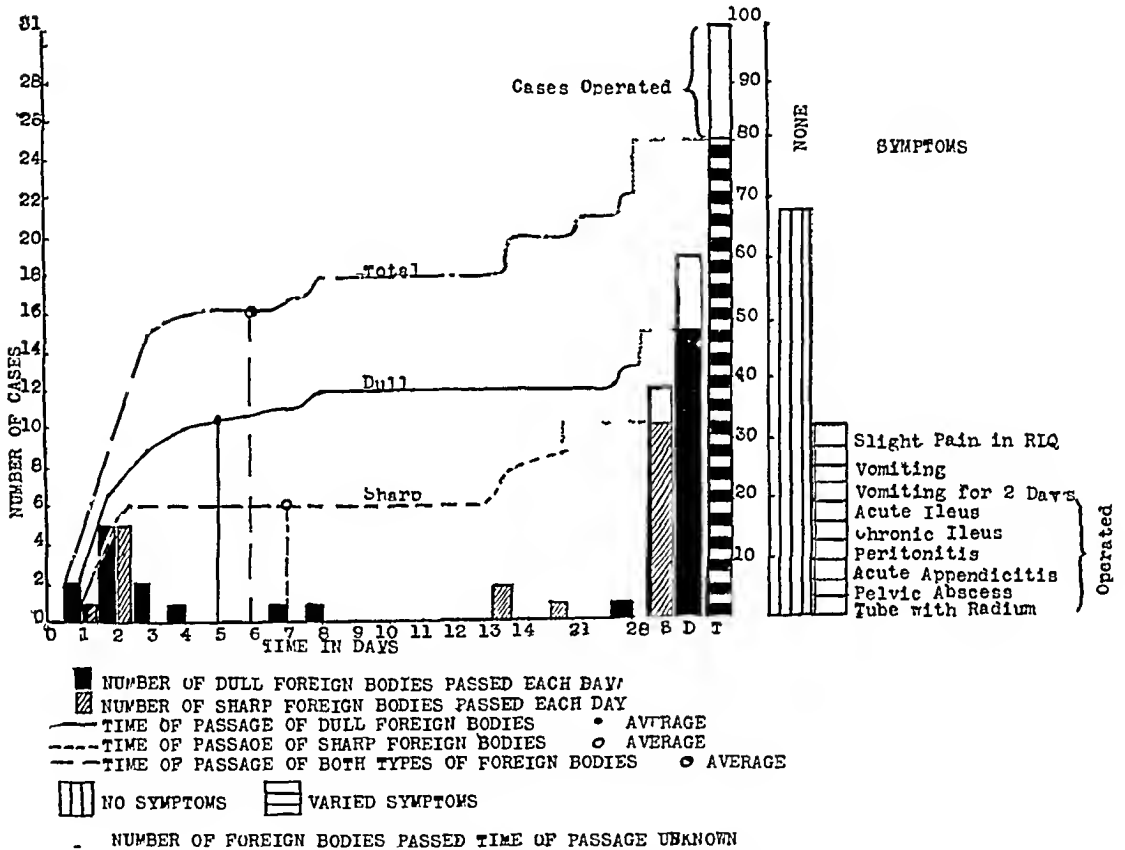


FIG 2 —Foreign bodies in the intestine

- 2 The largest number (75 per cent) occurred among babies and children under ten years of age
- 3 The cases were about equally divided between the sexes (not very significant in view of No 2)
- 4 Dull objects were slightly preponderant
- 5 Among sharp objects pins were preponderant
- 6 Most of the foreign bodies (80 per cent) were passed
- 7 Of the sharp foreign bodies only two (15 per cent) perforated the gut
- 8 The minority of cases that pass foreign bodies have symptoms or signs
- 9 It takes a sharp foreign body a little longer to pass than a dull foreign body

Practical Anatomy and Movements of the Intestine—The intestinal canal is a long, elastic, distensible, and motile tube, varying in diameter at different portions and characterized by natural folds in its wall, valvular formations, angulations, and mobility throughout its greater extent Nor-

mally, it offers points of possible delay or obstruction to a foreign body as follows

- 1 The junction of the second and third part of the duodenum, due to the flexure and the sphincter muscle described by Ochsner
- 2 The ileocæcal region because of the angular insertion of the ileum
- 3 The lumen of the appendix, which may harbor a foreign body due to



FIG. 3—X-ray picture of pin in intestine of eleven-year-old girl the head of which perforated the sigmoid six days after it was accidentally swallowed

incompetency of the ileocæcal valve

4 The junction of cæcum and ascending colon, because of the presence of the "frenulum valvulæ coli"

5 Flexures and haustræ of the large intestine, including the rectal ampulla and crypts of Morgagni

In order of frequency, the rectum, cæcum and sigmoid probably offer the best anatomical sites for the arrest of a foreign body. The movements of the intestine which normally are controlled centrally, through extrinsic nerves, and peripherally,

by the neuromuscular mechanism in the wall of the intestine, may be grouped under the following heads

- 1 Long tonic contractions (pendular movements)
- 2 True peristaltic contractions
- 3 Rhythmic segmental contractions
- 4 Antiperistaltic contractions, present mostly in the large intestine

A foreign body might normally encounter a bar to further progress by one of the anatomical factors mentioned above. On the other hand, the tendency is for propulsion forward by intestinal movements, which in themselves might cause the foreign body to come in intimate contact with the intestinal wall. Nature's usual protection and reaction against this contact will be discussed later.

Reference to Poulet's¹ classic on foreign bodies in general and to Peter's² short monograph will give many amazing, unusual, and curious examples of foreign bodies in the intestine. Their presence may be due to migration from a neighboring organ, cavity or extremity, to accidental or deliberate ingestion or to introduction through the anus into the rectum. Deliberate

FOREIGN BODIES IN THE INTESTINE

ingestion may result from an act of insanity, a dare, a habit or medicinal therapy. Accidental swallowing of foreign bodies is by far the most common. Fish bones, chicken bones, and fruit pits, normally present in food, are frequently swallowed in careless and rapid eating. On the other hand, individuals may unknowingly swallow foreign bodies such as slivers of wood in bread. A foreign body placed in the mouth temporarily may be swallowed through absentmindedness or a sudden inspiratory effort. I recall a patient who went to sleep with a toothpick in his mouth and swallowed it. In our series, St. John removed from the duodenum 50 mgs of radium in a brass container. This had been placed in the nose for an ethmoidal condition and was accidentally swallowed.

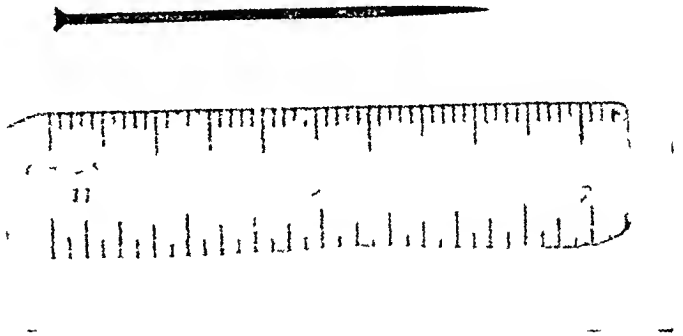


FIG. 4.—Pin shown in Fig. 1 after operation

The ingestion of foreign bodies by the insane is a common occurrence. Ross³ reports a case of an insane woman, who, after a six months' history of lower abdominal pain was found to contain twenty pieces of wire in a resected piece of ileum. Stough⁴ cites a case of an adult insane male who swallowed a knife six and one-quarter inches long with a two and one-quarter inch blade. In several months a fecal fistula formed in which the knife was found. A female inmate of sixty-six was autopsied by Hill⁵. A palpable mass in the right iliac fossa, the size of a tangerine orange, was found to be a hair-ball in the ileum. Hosford⁶ reports post-mortem findings on a lunatic, who, while alive, had been known to pass stones and pieces of wood and cloth. Autopsy showed innumerable articles, including wood, linens, neckties, and stones, in the jejunum, ileum and sigmoid, with a marked chronic pelvic peritonitis. It is remarkable that there was no ulceration or perforations of the gut wall. During a laparotomy on a neurotic woman, presumably for appendicitis, Gray⁷ found the bowel perforated by a hairpin which had entered the abdominal wall. There were present also ten and one-half hairpins, seventy-eight ordinary pins, one nail, and one piece of steel three-quarters of an inch long. The patient finally admitted that she was in the habit of putting one or two pins in her mouth before going to bed in the event that she should awake and require them.

Pringle⁸ records the case of a man of twenty who swallowed seven nails one inch long "on a dare". Eight days later he came to operation and the nails were found in the cæcum. He died of a post-operative ileus and autopsy showed early necrosis of cæcum and ascending colon. Another patient (Genglaire⁹) swallowed thirty frogs and had no symptoms until they reached the rectum. A large mass of tangled frog bones was extricated manually.

Material taken for therapeutic purposes such as bismuth or bran might accumulate in an already pathological colon and eventually create a foreign body. Vegetable fibres have been known to do the same. It is a well-known fact that the residuum of oatmeal, consumed in large quantities by many inhabitants of Ireland, may cause intestinal obstruction.

Women and babies occasionally make a habit of swallowing one particular

type of foreign body As an illustration, we saw a colored child who was accustomed to pluck its own crimped hair and swallow it In 1914, Heazlit¹⁰ reported 70 cases of hair-ball in the gastro-intestinal tract which he had collected from the literature The habit of hair swallowing is practically confined to females, who are, as a rule, normal mentally Operative therapy is usually necessary to relieve symptoms

We will mention only in passing, the presence of gall-stones or scybalous masses in the intestine

Although almost any type of foreign body may gain access to the intestine,



FIG 5 — Nail which remained in caecum of six year-old boy for three weeks and was then suddenly passed after a barium enema

those most frequently found are metal, bone, fruit pits, glass, hair, wood and cloth Deliberate ingestion, usually accomplished with less choking and pain than accidental ingestion, accounts for the remarkable size of some of these bodies A 6½-inch dinner fork with a 4-inch handle was swallowed by a female of twenty-five,¹¹ a 2½-inch scarf pin with a small glass ball at one end by a child of two,¹² a closed pocket knife 2½ inches long by a child of seven months,¹³ a 2-inch iron nail by a two-year-old baby,¹⁴ a 3¾-inch toothbrush by an infant eight

weeks old,¹⁵ and in our series a 3-inch nail with a large head by a boy of six

What happens to the foreign body in the intestinal lumen and the reaction that may be produced in the intestinal wall constitute a most important aspect of this entire subject Many are recovered in the same condition as before ingestion, but the intestinal juices may cause a metal object to break in two, or foreign bodies may be surrounded by some natural protective coat consisting of mucus, unabsorbed food or faeces Glass is usually rounded off by the digestive juices, and Simmons and Von Glahn¹⁶ found that the ingestion of ground glass has no toxic effect nor does it produce any permanent lesion on the gastro-intestinal tract of dogs Faber¹⁷ gave food with fishbones to adults, some of whom had a normal gastric acidity or hyperacidity and some of whom had a subnormal acid gastric content In the former group the faeces showed no fishbones, while they were present in the latter He infers that in the first instance normal decalcification could take place

FOREIGN BODIES IN THE INTESTINE

Although nature's protection facilitates the passage of most foreign bodies, symptoms frequently develop from obstruction, traumatism to or perforation of an organ. Thus we may find a peritonitis, peritoneal abscess, or fistulous communication between intestine and intestine, or between intestine and some other organ, such as the bladder. Other foreign bodies that are thin and sharp may perforate the gut, producing few or no symptoms, and travel through the peritoneal cavity or along muscle planes or into a large blood-vessel. Such a procedure usually takes a long time. David¹⁸ cites

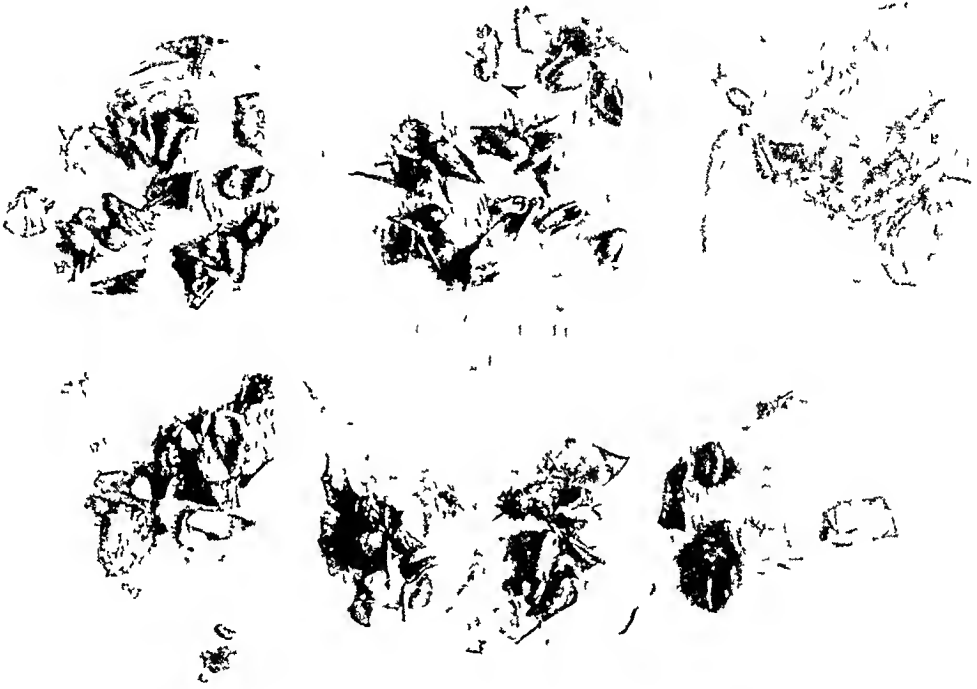


FIG. 6.—Unknown type of foreign body causing intestinal obstruction

a case of an adult who, after swallowing a fishbone, had a cystitis for twenty-nine months. The bone was then passed per urethram, having migrated from the rectum into the bladder. Cordier¹⁹ reports the case of a boy of sixteen, who had had an attack of pain in the right lower quadrant three years previously, in whom a diagnosis of typhoid fever was made. Subsequently he had urinary tenesmus with tenderness in the hypogastrium. Two stones were found in the bladder, one of which was incorporated with a veil-pin which had protruded into the bladder. A sane but neurotic male of thirty was operated on by Bell²⁰ for abdominal pain. He found a needle with one end in the stomach and the other in the liver, another needle free in the gastrocolic omentum, and a 4-inch hatpin piercing the duodenum. Nine years after a man had swallowed a darning needle, it was extracted from the posterior aspect of the hip-joint (Woodman,²¹). Mueller²² had a case in which a pin was found lying across the ureter nine years after ingestion. In a woman who came to autopsy after having had an œdema of both lower

extremities, Thompson²³ found a needle with a surrounding thrombus in the inferior vena cava. Many cases have been operated presumably for appendicitis, in which a foreign body in or near the appendix was found to be the real etiological factor, Pike,²⁴ McCrae,²⁵ Speese,²⁶ Heitz.²⁷ In an analysis of 63 cases of foreign body appendicitis, Fowler²⁸ states that, of the larger foreign bodies, straight pins are found most frequently and that the

symptoms are chronic in the majority of cases. Bidwell²⁹ found foreign bodies in about 20 per cent of the appendices that he removed, and he believes that symptoms were produced not so much by the foreign bodies as by concretions formed around them.

Two Italian observers, Zoja³⁰ and also Omboni,³¹ were impressed with the usual favorable outcome of foreign bodies in the intestine in humans and experimentally in dogs. To ascertain the reaction of the intestinal wall to foreign bodies which permits their successful progress and evacuation with such remarkable frequency, Exner³² conducted a series of beautiful and carefully controlled experiments on the intestine



FIG 7 —Röntgenogram of open bar-pin in intestine of five months old baby passed in three days

of dogs and cats. He found that if the mucosa of the small intestine is stroked or pricked, an anæmic area is formed after a period of time varying from several seconds to two minutes. In the centre of this area there is an inconstant concavity surrounded by a muscular and contractile wall. Reference to Fig 10 will show the reactions noted in confirmatory experiments on the dog's intestine. The same results were noted when the experiment was performed with the sero-muscular layer removed. In both cases these phenomena disappeared in about one minute. In the second experiment the histological examination showed that the concavity was due to contractions

FOREIGN BODIES IN THE INTESTINE

of the muscularis mucosa and of the fibres between the lymph follicles and the glands, and that the anæmic area was produced by compression of the blood-vessels caused by these contractions. An excised piece of intestine showed the same reactions as above, proving that the ganglia in the intestine itself are the controlling factors in their production. These results seem to be less constant in the large intestine.

Continuing his experiments, Exner proceeded to feed long-pointed glass splinters to cats and found that the places where the glass touched the stomach wall were drier than the surrounding mucosa. There was no wound, but at the point of contact a concavity was formed in an area of anæmia. In the small gut the glass was also embedded in concavities, but in the large intestine they were found in the natural folds. The serosa presented nothing abnormal.

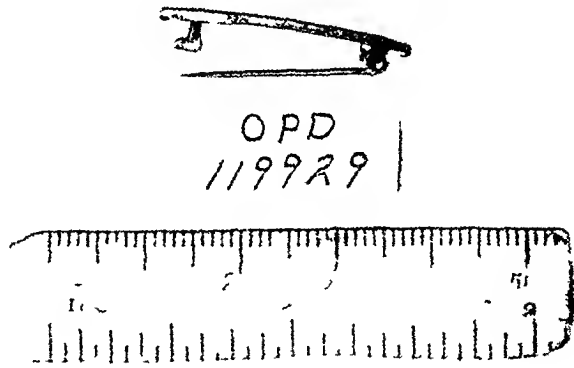


FIG. 8.—Pin seen in Fig. 7

A dog on which he experimented was given food in which fifty needles were incorporated, one-half of which had their points isoperistaltic and the other half points antiperistaltic. After twenty-four hours, forty-eight needles had been passed with the heads isoperistaltic and the other two with the points isoperistaltic.

Summarizing other experiments, about 800 needles were introduced, points isoperistaltic, into the stomachs of dogs and cats. All the animals were well before they were killed, and autopsy showed no peritonitis, and no visible injury to the mucosa. Furthermore, the number of needles passed with heads isoperistaltic were found in a ratio of 7 to 3 that were passed with points isoperistaltic. This means that the intestine has a tendency to pass pointed foreign bodies with blunt end forward.

The significance of these observations brings us to the following consideration of the reasons why pointed foreign bodies in the majority of cases proceed through the intestinal tract with heads isoperistaltic and are passed through the anus in the same position.

1 If the contents of the intestine are entirely fluid, the centre of the column moves faster than the periphery. At the mucosa, where the point of a foreign body may impinge, the rate of movement of the fluid content is practically negligible, and therefore the head, which is in the faster current, is pushed forward.

2 If the contents of the intestine are firm, and if a pin, traveling with the point forward, touches the mucosa, a concavity forms between the mucosa

and column of faeces at the point of contact, and the fecal mass pushes the head of the pin in an isoperistaltic direction

3 The muscular boundary of a concavity may stop the point of a pin and the adjacent faeces, causing part of the fecal mass to turn and force the head forward

4 The point of a pin may get caught in the natural folds of the gut, and

any of the three preceding factors may operate to push the head of the pin forward

With this knowledge of the mechanism of nature's protection against injury or perforation of the intestinal wall by foreign bodies, it is easy to understand how some foreign bodies may lodge in the distensible tube for a long time, especially when they have been completely enveloped by undigested food particles or fecal material. In a six-year-old boy in our series a 3-inch nail apparently stayed in the cæcum for three weeks and then was suddenly passed. Smith³³ reports a case of a woman who

FIG 9 —Pin in intestine of three-year old child passed in fourteen days

swallowed a darning needle 1 11/16 inches long and passed it twenty years later!

In about 90 per cent of the cases of sharp foreign bodies analyzed in our series there was no perforation. When perforation does occur it probably is caused by pressure necrosis superinduced by a local inflammatory process, especially in the large intestine, where bacterial flora are profuse. Violent peristalsis or the act of defecation might drive the foreign body into the intestinal wall. Anatomical and pathological conditions, such as the narrow lumen of the appendix, the sacculations of the large gut, carcinoma, tuberculosis, diverticula, hernia, or any factor causing a chronic obstruction, will clearly predispose to perforation. Perforation in the large intestine is more frequent since the narrower lumen of the small intestine makes it difficult for the foreign body to turn around and its slow vermicular action makes lodgement or perforation here unlikely.

FOREIGN BODIES IN THE INTESTINE

Most foreign bodies in passing through the intestine produce no symptoms. When symptoms occur the diagnosis must be made on a careful history and a physical examination followed by the various laboratory aids, especially the X-ray. Such symptoms may be summarized as follows:

- 1 A mild clamp when they pass through the intestine naturally
- 2 A clamp or pain in one spot when they pass through slowly
- 3 Diarrhoea and mucus or blood in the stool from irritation of the intestinal mucosa
- 4 Intestinal obstruction
- 5 Pain, tenderness and constitutional symptoms from inflammation and pressure necrosis
- 6 Perforation

Treatment—The immediate course to be pursued following the ingestion

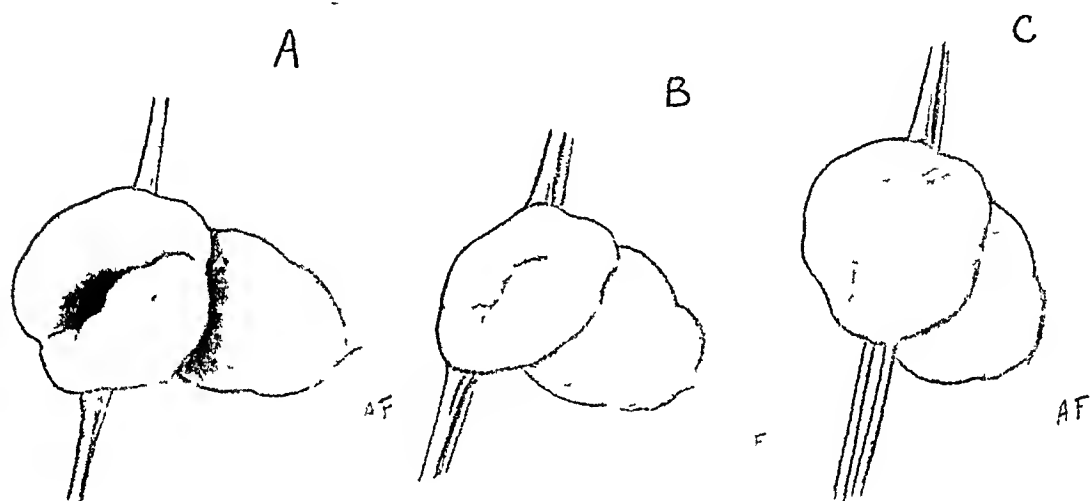


FIG 10—A Showing two small concavities produced on the mucosa of small intestine of dog by gentle pries of needle point. They were preceded by temporary area of anemia and appeared in about two minutes gradually becoming deeper and slowly disappearing in about ten minutes. B Similar trough-like reaction produced by gentle stroke of needle point. It disappeared in about fifteen minutes. C Concavity with surrounding area of marked anemia produced by pushing into mucosa gently with blunt end of artery clamp. The anemia persisted for about twenty minutes and the concavity fifteen minutes.

of a foreign body is expectant. The size and the nature of the foreign body, the possibility of its localization, and the condition of the intestine itself will decide the wisdom of a subsequent radical procedure. The fear and the actual danger of the potential harm from the foreign body are never to be discounted. The unexpected may occur at any time from an apparently innocent foreign body. Close observation and immediate operative therapy when the symptoms so variant are of paramount importance. On the other hand, we have shown by statistics and by experimental work that there is a natural tendency for the spontaneous passage of foreign bodies without untoward symptoms. To help nature, two factors are essential: the prevention of intestinal hypermotility, and the ingestion of such material as might aid in the formation of a protective coat around the foreign body. The idea of hastening the exit of a foreign body by the use of a cathartic is, I think, a mistake. Powerful intestinal contractions may drive the foreign body into or through the intestinal wall. Bran, agar-agar, whisps of cotton, pultaceous

SYNOPTICAL TABLE OF CASES OF FOREIGN BODY IN THE INTESTINE

Hospital No	Age	Sex	Foreign body	Symptoms	Treatment	X-ray findings and fluoroscope	Result	Complications
67277	9	Male	Melon seed and hairs in appendix	Acute appendicitis	Appendectomy		Improved — perhaps foreign body cause of symptoms. As examination of appendix and abdomen negative	
Dr Carp Private case	11	Female	Bank pin	None until 7th day — acute lower abdominal pain with signs of peritonitis	Dietetic until perforation no exsitor oil—cereals agar-agar bread	Six days after ingestion pin in L L Q	Cured after operation (laprotomy extraction of pin drainage)	Head of pin perforated sigmoid, local peritonitis
50788	64	Female	Numerous foreign bodies (fruit seeds, leaves feculites)	Previous acute ileus (volvulus of small intestine) followed by operation with reduction of volvulus. Chronic ileus followed by an acute attack	Ileostomy (13 days later) Removal of foreign bodies Removal of specimen		Died from post-operative complications	Chronic ileus and ulcer of colon
55115	35	Female	Prune pit covered with calcium phosphate crystals	Acute ileus	Exploratory operation		Died	(Autopsy) Foreign body impacted in sigmoid at point of stenosis by adhesions—resulting ulcer—and perforation—associated acute diphtheritic colitis
62323	21	Male	Piece of bone (bird?) 2.5 cm long and 2 mm in diameter	1 Pain in L U Q radiating to L L Q and lasting 3 weeks 2 Palpable mass in L L Q	Incision and drainage of pelvic abscess with removal of foreign body (Abscess surrounded by large coils of small intestine and sigmoid)		Improved	Pentoneal abscess
64370	15	Female	50 mg radium in brass container which screened all but gamma rays (Radium had been placed in nose for an ethmoidal condition)	None	Enterostomy, enterorraphy and removal of foreign body from duodenum (operated on same day as swallowed)	X-ray—radium tube in region of stomach (apparently)	Cured	

FOREIGN BODIES IN THE INTESTINE

51797	6	Male	Nail—3" long	Slight pain in R L Q —of short duration	Castor oil by mother. Bow- els kept open by enemias when needed. Given bar- ium enemias day before passing of foreign body	Two days later in cecum Repeated X-rays during following 3 weeks, nail apparently remaining in cecum	Passed 3 weeks later
23350	3	Female	Pin with large top	None	Mucilaginous foods and cotton	In second portion of duode- num	Passed 14 days after ingestion
17807	11 mos	Female	Safety pin (closed)	Vomited once, other- wise negative	None mentioned	Pain in abdomen	Passed 3 days after ingestion
30458	2½	Male	Screw ¼" long	None except for slight tenderness in R L Q	Soft diet containing much residue plus mild cathartic	Screw in pelvis 24 hours later	Passed screw 3 days after ingestion
94811	1 yr 8 mos	Male	Penny	None	Castor oil	Fluoroscope ½ hour later— penny in fundus of stom- ach	Passed in 20 hours
130507	2	Male	Toy metal horse ½" square	None	Castoria	Foreign body in duodenum ½ hour later. In lower right quadrant (cecum or terminal ileum one day later	Passed 2 days later
84898	16 mos	Female	Lead pencil 3 cm long blunt point	None	Dry bread, prune juice S S enema		Passed in 24 hours
18274	3	Female	Tin not painted 1" 1½"	None	Castor oil (by mother) veg- etable diet—agar-agar	24 hours later foreign body seen in R L Q	Passed in 74 hours
120086	2	Male	Tack	None	Rest bulky food, mild ca- thartic	10 minutes later, tack in stomach	Passed in 3 days
80997	2	Male	Penny	None	Castor oil		Penny appeared in stool 2 days later
119929	5 mos	Male	Bar pin (open) 1¼" long	None		On same day pin seen in stomach. Pin in R L Q 2 following days	Passed 3 days after ingestion
136220	5	Female	Straight pin	None	Bed, no cathartic	Pin in descending colon or proximal sigmoid 2 days later	Passed pin 3 days later
63672	16 mos	Female	Screw	None	Bread and castor oil	Foreign body in lower ab- domen one day after in- gestion	Passed foreign body 2 days after inges- tion
79560	7	Female	Penny	Vomiting 2 days	Castor oil		Passed in one week
86626	5	Female	Safety pin (closed)	None	Mashed potatoes, pan cakes water	Pin in small intestine to left side of abdomen below umbilicus—6 hours after ingestion	Pin passed 2 days after ingestion

SYNOPTICAL TABLE OF CASES OF FOREIGN BODY IN THE INTESTINE—Continued

Hospital No	Age	Sex	Foreign body	Symptoms	Treatment	X-ray findings and fluoroscope	Result	Complications
117269	2½ yrs	Female	Safety pin (closed)	None		Pin in L U Q (fundus of stomach) 2 days after ingestion 4 days later pin in same position	Passed 8 days later	
138862	1½ mos	Male	Safety pin (closed)	None		Pin in stomach same day	Passed 2 days later	
136220	5	Female	Straight pin		Bed no cathartics	Pin in stomach with head toward pylorus ½ hour later Pin in descending colon on proximal sigmoid 2 days later	Passed 3 days later	
130507	2	Male	Toy horse (metal) ½" square	None	11 tsp castor oil	In duodenum 15 minutes later In cecum or terminal ileum 1 day later	Passed 2 days later	
129135	3	Male	Penny	None	Castor oil	None	Passed in 4 days	
142131	21	Female	Needle	Pain in R L Q	Cathartic	Needle in L U Q	Passed in 2 weeks	
128735	3½	Male	Nickel	Pain in R L Q	Cathartic	Needle in stomach	Passed in 4 weeks	
55112	27	Male	Intra-vascular feeding tube	None	Fluids by mouth <i>Exploratory operation 14 days later</i> —tube found in cecum but not removed	4 days later—object in duodenum 23 days later—in terminal ileum or rectum 28 days later—no evidence of tube	Tube is discharged—date unknown	Infection of abdomen in 11 wound healed 24 days later
118098	16	Male	Straight pin	None	Bulky food	Fluoroscope—one hour later shows pin in stomach	Passed—time unknown	
7914	5	Female	Whistle	None	Large meal followed by emetic (advice of Dr Lambert who believes foreign body will not pass pylorus)	3 days later foreign body in stomach	Passed in several days	
68435	3½	Male	Ring	None	Food with much carbohydrate	Ring in stomach or duodenum 4 days after ingestion	Lost to follow-up	
10911	10 mos	Female	Pin with large top	None	Soft diet with wisps of cotton in oatmeal—also potatoes	Two days later pin in stomach	Observed in ward for 6 days—foreign body not noticed in stools	
12281	8½	Female	Hair pin 3" long	Nausea and pain in epigastrium for 2 days	Castor oil		Lost to follow-up	

FOREIGN BODIES IN THE INTESTINE

98275	26	Female	Tooth with sharp screw attached	Vague pains in epi- gastrium	Diet	Lost to follow-up
96197	2½	Male	Nickle	None	Castor oil (by mother)— bulky food	Not passed after 1 week's observation
54873	38	Female	Fish-bone	None—symptoms of existing ulcer and gall-stones	Gastro-enterostomy for ulcer (duodenal) and gall- stones—fish-bone found in course of operation, situ- ated subserously and no ulcer in its vicinity	Improved
55871	14	Female	Pin	Some generalized ab- dominal tenderness		Lost to follow-up
NOTE—No symptoms treatment etc.—foreign body discovered in course of general physical examination in a case of acute rheumatic fever						
18222	2 yrs and 9 mos	Female	Needle	None at first later constipation and one vomiting	Regular diet with oatmeal and potato	Discharged as unim- proved—case not followed
7520	25	Male	False molar tooth with plate attached (2 cm long)	Immediate stick- ing sensation in left sub-diaphragm- atic region Other- wise negative	Bulky food	Lost to follow-up
128906	3	Female	Small screw ½" long	Abdominal pain—not severe	Castor oil, soft food with bread	Lost to follow-up
113981	7	Male	Black-headed pin	None	Bulky food	Lost to follow-up
109136	1	Male	Small ring	None	Castor oil oatmeal gruel and agar-agar	Lost to follow-up
108801	2½ yrs	Male	Pin	None	Castor oil	Lost to follow-up
117786	16	Male	Small plate with 2 teeth	None		Lost to follow-up
110057	3	Female	Nickle	Slight gagging at time of ingestion Other- wise negative		Lost to follow-up
118005	3	Female	Whistle	None	None	Lost to follow-up
151335	3½	Female	Penny	None	None	Lost to follow-up

and stodgy food leaving a residue, such as oatmeal, vegetables, figs, raisins, et cetera, with the addition of a lubricant such as mineral oil, would help to surround the foreign body with a protective coat. When present in the large intestine longer than expected, barium or oil enemata may be used. If symptoms are produced when a foreign body gets to the rectum, it is better to remove it with the finger or proctoscope. Ambulatory treatment is not contra-indicated, although rest is to be desired.

CONCLUSIONS

I Most foreign bodies of the intestine are ingested accidentally and in the majority of cases are evacuated spontaneously regardless of their size, shape, material and number.

II Trauma from intestinal foreign bodies is guarded against by the protective mechanism of the intestinal wall which produces concavities with muscular boundaries on the mucosal aspect at the points of contact (Exner). This causes an increase in diameter of the intestinal lumen which facilitates propulsion forward of the foreign body by peristalsis and movement of intestinal contents.

III Foreign bodies, pointed at one end, have a tendency to pass through the intestine with point antiperistaltic and to be evacuated blunt end forward. In this position the point is less likely to impede the progress of the foreign body through the intestinal canal and consequently foreign bodies with blunt end forward will be evacuated more quickly than those with point forward.

IV A foreign body may travel from the intestine into another organ or into the peritoneal cavity and from there into muscle planes, with little or no symptoms. When late symptoms occur they are referable to the other organ or tissue involved.

V Conservative treatment of intestinal foreign bodies is indicated in the large majority of cases as shown by statistics and experimental work. Careful observation, rest, and food, or any substance leaving a large intestinal residue may help the successful passage of a foreign body. Cathartics are interdicted.

VI Obstruction or acute perforation of the intestine or impaction of a foreign body in its wall demands operative therapy.

REFERENCES

- ¹ Poulet, A. Treatise on Foreign Bodies in Surgical Practice, 1881.
- ² Peters, Richard L. B. Ueber spitze fremdkörper in magen-darmkanal, Koenigsberg, 1902.
- ³ Ross, George G. Foreign Bodies in the Small Intestine. ANNALS OF SURGERY, 1916, vol. LXIII, pp. 247-248.
- ⁴ Stough, D. F. Knife-swallowing. Report of a Case. Jour. Oklahoma Med. Assn., 1918, vol. VI, p. 331.
- ⁵ Hill, W. B. A Case of Hair-Ball in the Intestine. Lancet, November 29, 1913, vol. II, p. 1539.
- ⁶ Hosford, A. Stroud. Foreign Bodies in the Intestine. Brit. Med. Jour., April 13, 1912, vol. I, p. 830.

FOREIGN BODIES IN THE INTESTINE

- ⁷ Gray, H M W, and Souper, H R Case of Multiple Foreign Bodies in the Colon Operation and Recovery Brit Jour Surg, 1914-1915, vol 11, pp 714-717
- ⁸ Pringle, J Hogarth Removal of Seven Nails from the Ascending Colon Edinb Med Jour, 1909, vol 11, pp 463-464
- ⁹ Genglaire Corps etrangers du rectum Le Progres Med, August 12, 1905, T 21
- ¹⁰ Heazlit, Ledra Hair-Balls of the Stomach and Intestine Jour Amer Med Assn, January 10, 1914, vol 111, pp 107-110
- ¹¹ Lees, Kenneth A A Dinner Fork in the Stomach and Duodenum Lancet, February 22, 1919, vol 1, p 298
- ¹² McGuire, J B Passage of a Scarf Pin Med Brief, 1904, vol 111, p 34
- ¹³ Brown, P H Passage of a Knife in a Child of Seven Months Jour Minn Med Assn, November 15, 1905, vol 11, p 439
- ¹⁴ Griffith, J deB Swallowing a Nail Med Jour Austral, September 21, 1918, vol 11, p 257
- ¹⁵ Sneed, O Toothbrush Swallowed by an Infant, Extracted From Abdominal Abscess Memph Med Month, 1896, vol 11, p 72
- ¹⁶ Simmons, James S, and Van Glahn, William C The Effect of Ground Glass on the Gastro-Intestinal Tract of Dogs Jour Amer Med Assn, December 28, 1918, vol 111, pp 2127-2128
- ¹⁷ Faber, Knud Ueber graeten als fremdkoerper im darm und ueber knochenverdauung Berl Klin Wchnsch, August 29, 1898, vol 111, pp 768-773
- ¹⁸ David, I An Errant Fishbone Brit Med Jour, February 2, 1918, vol 1, p 166
- ¹⁹ Cordier, A H Some Unusual Surgical Cases—Migration of Pin From Intestine into Bladder Amer Jour Clin Med, 1907, vol 11, p 1001
- ²⁰ Bell, J Migration of Needles From Intestines Into Surrounding Tissues Montreal Med Jour, 1904, vol 111, pp 108-112
- ²¹ Woodman, M S Foreign Bodies in the Alimentary Canal in Children Trans New Hamp Med Soc, 1897, pp 162-170
- ²² Mueller, George P Foreign Body Removed From Abdomen Nine Years After It Had Been Swallowed ANNALS OF SURGERY, 1918, vol 117, pp 380-382
- ²³ Thompson Quoted by Poulet¹
- ²⁴ Pike, J B Foreign Body in Cæcum Simulating Appendicitis Brit Med Jour, 1919, vol 11, p 413
- ²⁵ McCrae, D Discussion of²²
- ²⁶ Speese, J Perforation of Ileum by Foreign Body Followed By Symptoms Simulating Appendicitis Trans Phil Acad Surg, 1914, vol 11, p 158
- ²⁷ Hertz, M J Perforation de l'appendice par une arête de poisson Bull et Mem Soc Anat de Par, 1912, vol 117, pp 239-242
- ²⁸ Fowler, Royale H Foreign Body Appendicitis With Special Reference to the Domestic Pin, An Analysis of 63 Cases ANNALS OF SURGERY, 1912, vol 11, pp 427-436
- ²⁹ Bidwell, Leonard A Foreign Bodies in the Vermiform Appendix Lancet, September 30, 1911, vol 11, p 944
- ³⁰ Zoja, G Sulla possibilita di deglutire ed evacuare aghia esperienze del prof G Z Gazz Med Ital Lombardia, 1867, Anno 26, Serie Quinta Tomo vi, pp 200, 217, 282, 329
- ³¹ Omboni, Vincenzo Sulla deglutizione di aghi e spilli e sul loro decorso nel canali digerente esperienze e considerazione di O V Annali Universali di Medicina, 1869 Tome 208, pp 551-592
- ³² Exner, Alfred Wie schuetzt sich der verdauungstract vor verletzungen durch spitze fremdkoerper? Arch f d ges physiol, 1902, vol 111, pp 253-280
- ³³ Smith, Heywood A Needle in the Alimentary Canal Brit Med Jour, January 17, 1920, vol 1, p 81

THE REPAIR OF INJURIES TO THE POSTERIOR CRUCIAL LIGAMENT OF THE KNEE-JOINT*

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RUPTURE or stretching of the posterior crucial ligament of the knee-joint is an injury which, until recently, has baffled all efforts to bring about satisfactory repair. In spite of prolonged immobilization of the joint in full extension, or of various operative attempts to suture or reconstruct the ligament, the patient is almost invariably left with a knee in which the femur dislocates violently and painfully forward, whenever weight is borne on the flexed limb. As a rule, such patients are condemned to wearing cumbersome apparatus or to an operation to eliminate motion from the joint.

By far the most important paper on injuries of the crucial ligaments is that of Ernest Hey Groves, of Bristol, published in the *British Journal of Surgery*, 1919-1920. In it he reviews all previous attempts at surgical repair of the ligaments, and describes in detail a new method of operation which he had briefly reported previously (*Lancet*, November 3, 1917), which is brilliant in its conception and in many instances has been highly successful. This operation consists of a free exposure of the interior of the joint by an anterior "U"-shaped incision, the removal of the synovial membrane from the injured ligament and a reconstruction of the ligament by means of a transplant of fascia lata or of the semitendinosus tendon.

A short time after the publication of Hey Groves's preliminary paper, Alwyn Smith (*British Journal of Surgery*, 1918-1919) recommended a modification of the method as applied to the anterior crucial ligament, which substituted a split-patella incision for the extensive reflection of the anterior portion of the capsule of the joint, and added a repair of the internal lateral ligament.

In his second paper Hey Groves (*British Journal of Surgery*, 1919-1920) criticized this modification on the grounds that the incision through the patella did not allow a wide enough view of the interior of the joint and made it impossible to place the new ligament in the exact place of the old one. Without a doubt the approach through the patella does not allow as complete an exposure of all the structures within the joint, but in our experience the exposure is sufficient for the purposes of the operation, and we have found no difficulty in placing the new ligament in the correct anatomical position. We feel, therefore, that any suggestion which will reduce the cutting of ligaments and synovial membrane and lessen the amount of exposure of the interior of the joint to the air should merit favorable consideration, and

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judging from our own experience and the reports of the results in patients operated on, the method described by Smith is satisfactory

The operations of Hey Groves and Alwyn Smith were nearly all performed for injury of the anterior crucial ligament which is much more frequently injured than the posterior. In these operations a new ligament, fashioned from a transplant of fascia lata or ileotibial band, was passed through drill holes in the tibia and the femur, which were so placed that the new ligament tra-

versed the cavity of the joint somewhat in the position of the injured ligament. When healing occurred between the transplant and the tunnel through the bone the new ligament assumed more or less perfectly the function of the injured crucial, and so prevented the tendency to subluxation. In the case of injuries of the posterior crucial, however, Hey Groves neglected to bury the posterior end of the new ligament in the tibia,

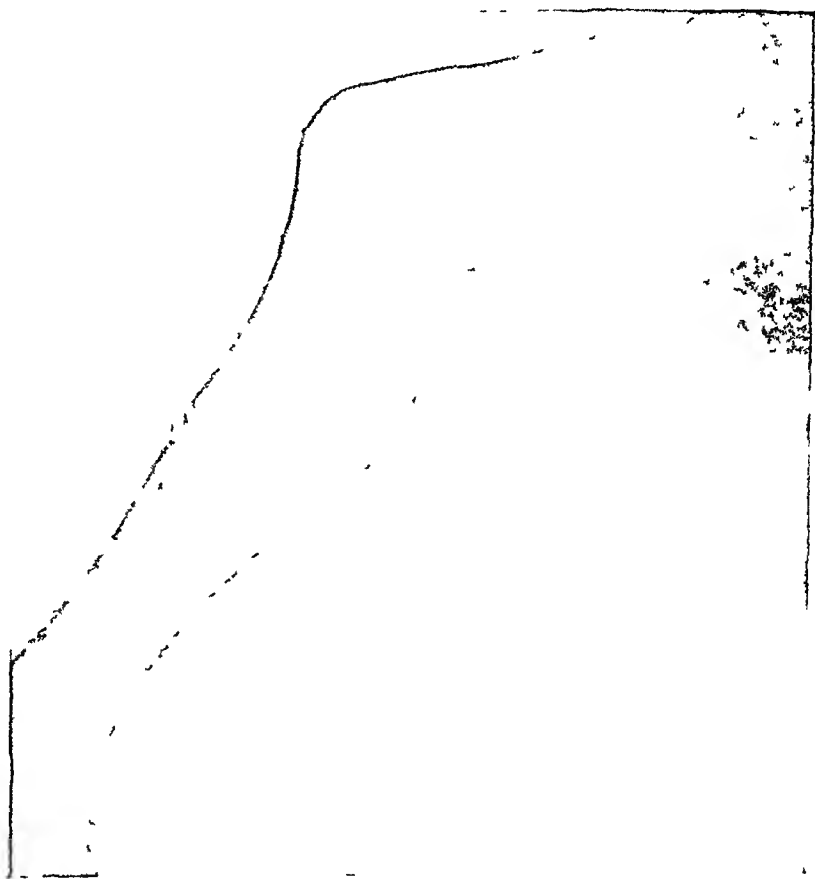


FIG. 1.—Photograph of the knee of the patient described in text in which the posterior crucial ligament had been ruptured. It shows the subluxation of the femur forward on the tibia. The dotted lines show approximately the normal relation of the leg to the thigh.

and in failing to do so would appear to invite failure of the operation. In the method which he describes the tendons of the semitendinosus and the gracilis are cut free from the muscle in the middle of the thigh, and the cut ends are drawn into the interior of the knee-joint by a pair of clamps, which are thrust from before backward through the posterior ligament. These tendons are then passed through a hole drilled through the internal condyle at the point of the anterior attachment of the posterior crucial and drawn taut. Unfortunately the new ligament has no secure anchorage to the tibia, except in so far as the tendons heal to the hole in the posterior ligament of the knee-joint, and consequently can have very little strength to resist the tendency of the femur to dislocate forward on the tibia. This appears to us as a defect in the method which might readily be remedied.

While recognizing, therefore, that to Hey Groves all honor is due for the

conception of the idea that the crucial ligaments might be replaced by transplants of the fibrous tissues, and for showing that the idea was feasible by practical demonstration on patients, yet we wish to point out certain features of his operation which appeal to us as amenable to improvement (1) The approach to the joint by way of an incision which passes transversely through the tubercle of the tibia and across the whole of the anterior portion of the capsular ligament appears to be a rough way of dealing with such an impor-

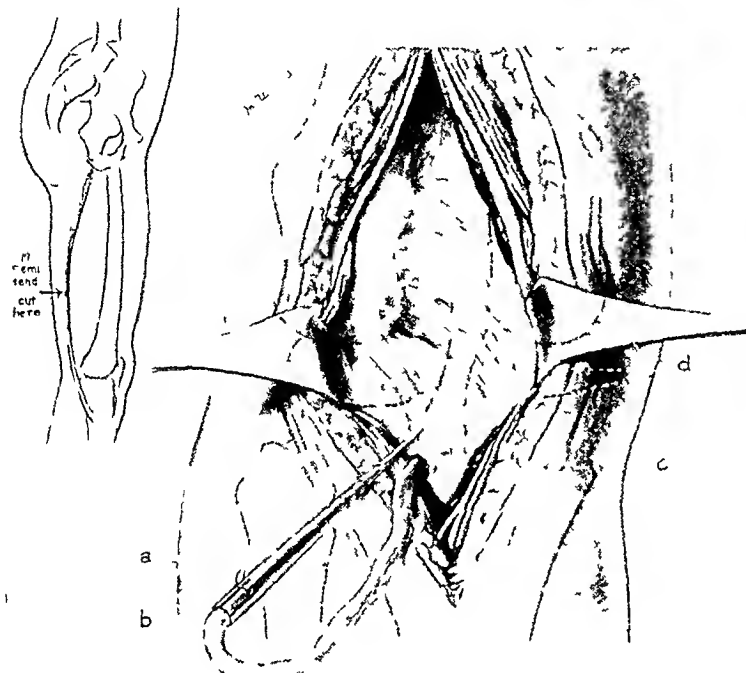


FIG 2.—Drawing designed to illustrate the steps of the operation through the posterior incision. The tendon of the semitendinosus has been detached from the muscle high in the thigh and freed down to its insertion into the internal surface of the head of the tibia. It has then been passed from before backward through a drill-hole through the head of the tibia and is ready for introduction into the joint. (a) Sharp pointed bodkin with the assistance of which the tendon has been passed through the head of the tibia and which is now in position to be thrust through the posterior capsule and along the remains of the posterior cruciate ligament without injuring the membrane. (b) tendon of semitendinosus, (c) drill-hole through head of tibia (d) dotted lines showing the outlines of the bones and the posterior cruciate ligament in the interior of the joint

covered by synovial membrane, and are bathed in synovial fluid instead of lymph, introduces a modification of the accepted method of transplanting fibrous tissues which, while it may be perfectly satisfactory, may result in pathologic changes which will lessen the efficiency of the operation (5) In the case of the operation for rupture of the posterior cruciate ligament the posterior attachment of the new ligament is not sufficiently secure

The suggestions which we have to offer were tried out first in the anatomical department and later on a patient who had sustained a rupture of the posterior cruciate ligament. They substitute for the extensive transverse incision the vertical split-patella incision or a vertical incision just internal to the patella. The use of such an incision removes the danger of increasing

tant joint and one which may lead to laxity of the ligaments when healing is complete (2) The damage to the synovial membrane caused by the primary incision and by the dissection necessary to expose the crucial ligaments is likely to result in synovitis and subsequent chronic arthritis (3) The prolonged exposure of the interior of the joint adds to the risk of infection (4) The placing of the transplant in the interior of the joint in such a way that its surfaces are un-

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the laxity of the capsule which attends the transverse incision and does infinitely less damage to the synovial membrane. Further, they reduce the time that the interior of the joint must be exposed, both by lessening the size of the incision and by eliminating the removal of the synovial membrane from the ligaments. Although the whole operation must be considered a prolonged one, the actual time during which the joint was open in the case we shall describe was not more than ten minutes. Again, the new ligament is introduced in such a way that it is entirely subsynovial. By this arrangement the transplant is placed in the exact anatomical position of the injured ligament and is left clothed by the synovial membrane which normally covers it. In this way the new ligament is buried throughout in vascular tissue, with no portion of its surface exposed in the joint or to the synovial fluid. The absence of practically all interference with the synovial membrane reduces to a minimum the post-operative inflammatory reaction and the possibility of adhesions or scars within the joint. And finally, a solid anchorage is provided for the new ligament, not only to the femur in front but also to the tibia behind, so that the reconstruction of the ligament is, as far as we can see anatomically perfect.

The patient was a young man, aged twenty-seven years, who six months previously had been struck down by a falling tree which fell across the outer side of his flexed knee in such a way as to rupture or stretch the internal lateral ligament and force the head of the tibia backward. The limb was immobilized in full extension for two months, until the hæmarthrosis and subsequent synovitis had disappeared, and he then began to walk. He was unable to return to work, however, owing to the circumstance that whenever weight was borne on the knee in any position except full extension the femur dislocated violently and painfully forward on the tibia for a full inch and the limb as a support became useless (Fig. 1). In addition, there was considerable lateral mobility of the joint even when in full extension, owing to faulty repair of the internal lateral ligament.

The operation performed consisted of several distinct steps (Figs. 2 and 3).

- 1 Through a long medial incision, which extended from the middle of the back of the thigh to the upper portion of the calf, the tendon of the semitendinosus was exposed and isolated. It was then detached from the muscle as high as possible in the thigh and stripped downward toward its insertion.

- 2 By way of the superficial portion of the split-patella incision the insertion of the semitendinosus was exposed on the inner surface of the upper end of the tibia and the whole tendon drawn through to the front of the leg from beneath the sartorius.

- 3 The lower portion of the posterior medial incision was then deepened and the space between the gastrocnemii muscles located and widened until the posterior ligament of the knee-joint and the upper portion of the posterior

surface of the head of the tibia came into view. The vessels and nerves were retracted to the outer side. A $\frac{1}{4}$ -inch drill was applied to the posterior surface of the head of the tibia at or slightly external to the midline and close up to the attachment of the posterior ligament to the bone. The drill was so inclined that it emerged on the internal surface of the tibia close to the

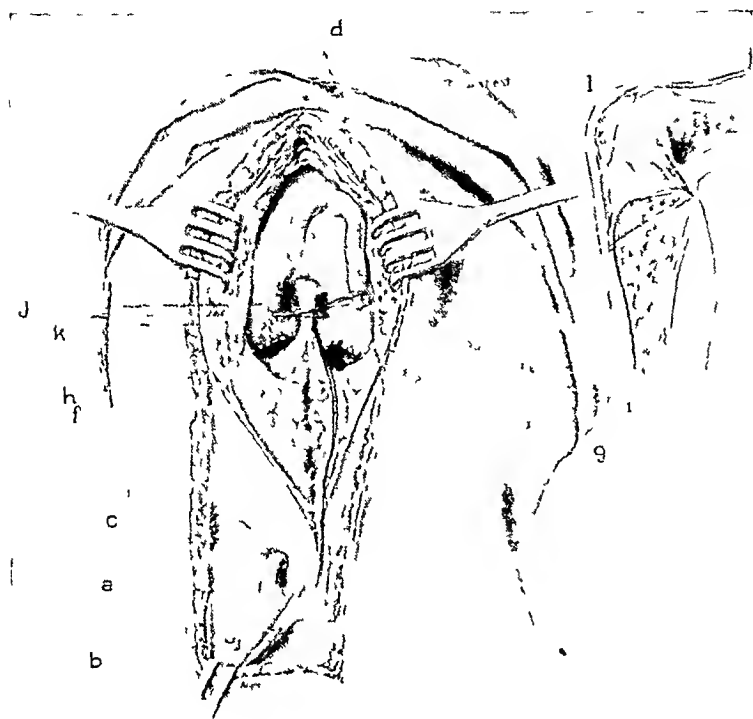


FIG 3.—Drawing designed to illustrate the steps of the operation through the anterior incision. In the lower portion of the incision the semitendinosus tendon can be seen at its insertion subjacent to the sartorius which has been retracted. It has been passed from before backward through the hole in the head of the tibia and with the knee flexed and the patella split and retracted the bodkin shown in Fig. 2 has been pushed forward through the posterior capsule and along the posterior cruciate ligament until the point punctured the synovial membrane at the most anterior point of attachment or the posterior cruciate ligament to the femur. The tendon was then drawn into the joint, the bodkin detached and the end of the tendon fastened to a flexible wire threader which has been passed through a hole drilled through the internal condyle of the femur in such a direction as to emerge in the joint just subjacent to the punctured hole in the synovial membrane covering the attachment of the posterior cruciate ligament to the femur. The tendon will now be drawn through the internal condyle and will disappear beneath the synovial membrane. (a) Insertion of semitendinosus tendon, (b) insertion of sartorius, (c) drill-hole through which the semitendinosus has been passed through the head of the tibia to appear at the back of the joint, (d) lateral halves of the patella retracted, (e) posterior cruciate ligament, (f) anterior cruciate ligament, (g) puncture hole in synovial membrane covering attachment of posterior cruciate ligament to the femur, (h) tendon of semitendinosus from which the bodkin has been detached and to which a silk ligature has been fastened preparatory to drawing it through the hole in the internal condyle of the femur, (i) wire-threader passed through hole in internal condyle which is indicated by dotted lines, (j) small incision over most prominent point of internal condyle of femur, (k) drawing of lateral surface of the medial half of the knee-joint which has been sectioned in the sagittal plane. It shows the tunnel through the head of the tibia and the line of the new ligament in the correct anatomical position.

insertion of the semitendinosus. The cut end of this tendon was then fastened into the butt end of a sharp-pointed bodkin, and by using the bodkin as a needle the tendon was passed through the head of the tibia until it appeared in the posterior incision.

4 The patella and patellar tendon were split longitudinally and the interior of the joint exposed. With the patient lying on his back and the knee flexed over the end of the table, the operator placed himself so as to look into the joint. The sharp-pointed bodkin was then pushed from behind forward through the posterior ligament of the knee at a point just above the hole in the head of the

tibia and in the line of the posterior cruciate ligament. As soon as the point of the bodkin had passed through the posterior ligament the operator could detect its presence within the synovial sheath of the posterior cruciate ligament by wiggling the point about. The bodkin was then pushed forward until its point punctured the synovial membrane at the most anterior point of the attachment

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of the posterior crucial ligament to the internal condyle of the femur. The bodkin and tendon were finally drawn out through the split-patella incision.

5 A small incision was now made over the subcutaneous portion of the internal condyle of the femur and the drill passed through this bone so as to enter the joint at the exact spot at which the bodkin had punctured the synovial membrane over the insertion of the crucial ligament. The bodkin was next detached from the tendon and the tendon fastened to the eye of a flexible wire-threader which had been passed into the joint through the hole in the internal condyle. The end of the tendon was then drawn through the internal condyle, and when it was drawn taut the new ligament was seen to disappear through the small puncture wound in the synovial membrane and become entirely subsynovial.

6 The knee-joint was now placed in full extension, the tendon drawn taut and its

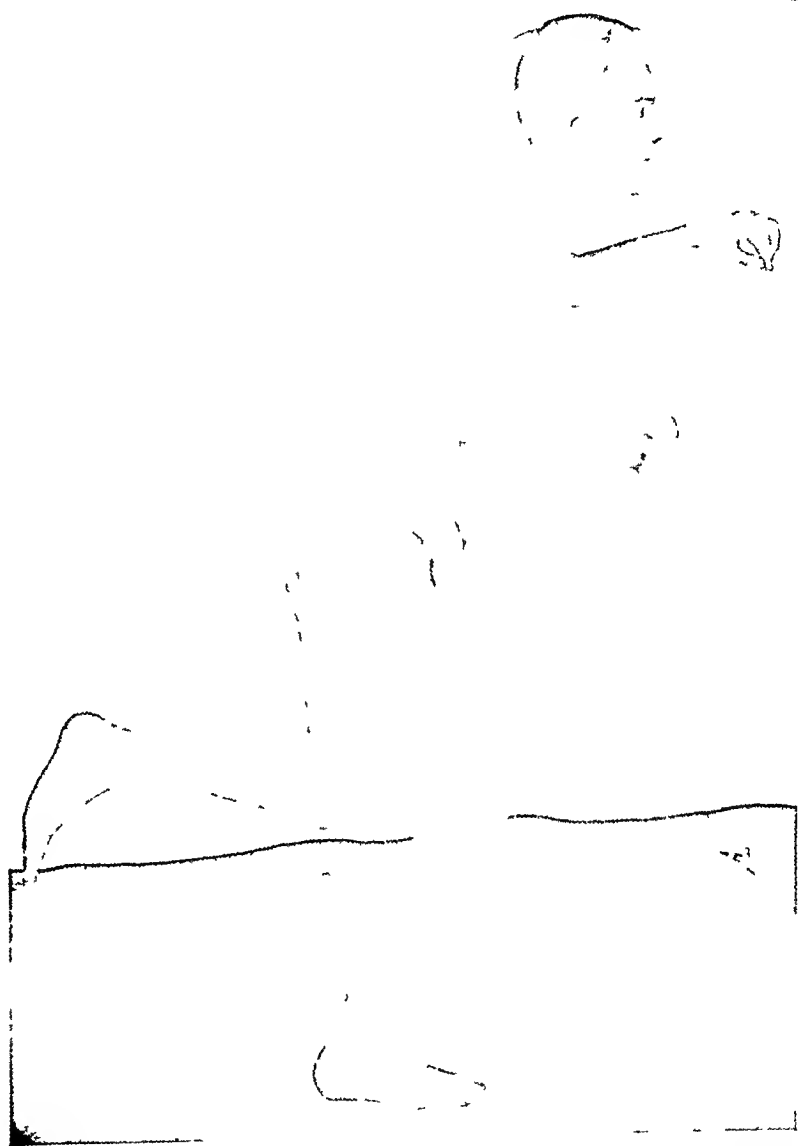


FIG 4 —Photograph of patient described in text six months after the operation. In this position the knee invariably dislocated previous to operation. Compare with Fig 1.

terminal end sewn down to the internal lateral ligament. The wounds were closed with catgut and horsehair and a plaster bandage applied from the toes to the top of the thigh.

Two months later the plaster was removed and the patient allowed to exercise the knee gently. At first there was not more than 20 degrees of motion, but within a week this had increased to 100 degrees. A slight synovial effusion appeared within twenty-four hours of the removal of the plaster, but this had disappeared in a week. The patient then began to walk.

Nearly three years have now elapsed since the operation. The patient

has been examined from time to time and has made steady improvement. He has worked as a chauffeur, as a waiter and as an ordinary laborer. He walks with a normal gait and has a complete range of motion in the joint. The previous tendency to subluxation has been cured and the new crucial ligament performs perfectly the functions of the old. His only complaint is that the joint is a little weak and the physical examination shows that this complaint is justified as he has more than the normal degree of lateral, rotary and antero-posterior mobility, sufficient to cause the knee to tire after prolonged heavy labor. The result as shown in (Fig. 4), however, is a great improvement on the original condition.

One feature of the operation for the repair of the posterior crucial ligament, which we think is applicable to the anterior crucial ligament as well, is the introduction of the new ligament in such a way that it is entirely subsynovial. On the only occasion, however, on which we have done a reconstruction of the anterior crucial ligament, the ligament and the synovial membrane covering it had been completely torn across and there was not sufficient synovial membrane left to cover the transplant. Judging from the description of the interior of the joints in cases that have been reported, it is unusual to find any evidence of injury to the synovial membrane, so that we intend when the occasion arises to make the new ligament subsynovial here also. We have done it on the cadaver and it can be accomplished with only two small slits in the synovial membrane, as it covers the old ligament at its points of attachment to the femur and tibia. When the transplant is drawn into position these slits close spontaneously and the new ligament disappears from view.

The question of the permanence of ligaments made from tendons or fascia is one that can only be solved by time. There is no doubt that if such tissues are transplanted from one place to another in the same individual, and if they are placed in contact with a good supply of lymph, they will continue to live unchanged. We have demonstrated, however, that in order that the whole thickness of a transplanted tendon may live, it is necessary that it be split open so that lymph may reach its interior. Ten years ago we described a method by which the tendons of paralyzed muscles could be converted into ligaments, and so prevent deformities of the feet, by burying them in troughs in the bone (*ANNALS OF SURGERY*, October, 1915). These new ligaments are undoubtedly permanent. In order that the adhesion of the transplanted tendon to the bone may be sufficiently strong to overcome the tendency to deformity, however, it is necessary to bury it in a tunnel or trough, and it is essential to remove all areolar tissue and to scarify its surfaces thoroughly. If these precautions are taken the fixation of the transplant to the bone will be strong and permanent. In the case of the crucial ligaments, therefore, if a stout transplant of fascia lata or tendon be used, such as will fit snugly into a $\frac{1}{4}$ -inch drill hole, and if the precautions necessary to successful tendon fixations are observed, we believe that the immediate successful results will stand the test of time.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held December 8, 1926

The Vice President, DR FRANK S MATHEWS, in the Chair

I ADENOMA OF THYROID—MALIGNANCY—PERFORATION OF PLEURA

DR CHARLES GORDON HEYD presented a woman, age fifty-three years, who entered the New York Post-Graduate Medical School and Hospital, October 26, 1926, complaining of swelling of the neck, duration forty years. When the patient was thirteen years of age she noticed a swelling on the right side of the neck, which at that time was diagnosed as "goitre." This tumor remained quiescent for thirty-five years when it gradually but continuously increased in size. About four months ago the patient noticed a small "lump" on the left side of neck which has grown very rapidly. Coincident with the increase in the size of the left-sided tumor the patient has had pain in the throat, with choking sensations, difficulty in swallowing, dry cough and increasing dyspnoea. In addition, during the last four months the patient has lost twenty pounds in weight but does not believe this is due to the difficulty in swallowing.

On physical examination the patient is obese, with evident dyspnoea and difficulty in swallowing, together with a hoarseness of the voice. Examination of the neck showed an adenoma of the right lobe of the thyroid approximately 12 cm. in length. On the left side there was another tumor approximately 10 cm. in length, extending out laterally and passing down beneath the left clavicle. There were no signs of hyperthyroidism, pulse rate 70, no tremor, no eye signs. Rontgenological examination demonstrated a retrosternal goitre and examination of the larynx revealed limited motion of the left cord, with the cord in abduction simulating a cadaveric vocal cord.

Operation was performed, October 27, 1926, under rectal-ether anaesthesia. As a preliminary safety measure an intratracheal breathing tube was inserted into the trachea. The operative findings revealed a large retrosternal mass evidently originating on the left side. It was hard and fixed to the surrounding muscular tissue and passed outward and downward beneath the carotid artery and jugular vein. Grossly the tumor strongly suggested an infiltrating carcinoma. On the right side was a somewhat smaller mass, much softer in consistency, passing downward beneath the clavicle but not encroaching on the midline and lying anterior to the carotid artery. There was no gross external evidence of malignancy in this mass. It suggested only a simple encapsulated adenoma. The operation consisted of a typical exposure for a thyroidectomy. Thyroid resection was begun on the right side with division of the superior pole and the anterior four-fifths of the right lobe were resected from above downward and the mass delivered easily without hemorrhage from below the clavicle. On the left side by reason of the perforation of the capsule of the thyroid there was deep penetration into the surrounding muscles. The mass was fixed posteriorly and was beneath the carotid artery, jugular vein and vagus nerve. It was densely adherent anteriorly to the carotid sheath. Resection was begun at the superior pole and the carotid

artery and jugular vein were separated from the mass by scalpel dissection. The lower pole of this mass extended well beneath the sternum and the clavicle on the left side and was apparently attached to the dome of the pleura in the left supraclavicular space. Upon turning this mass downward and forward on the chest it was rotated from the retrosternal space and delivered. Following this there was an escape of air. Examination of the trachea revealed no defect and although the laryngeal nerve was exposed in the dissection, it was left untouched. Deep in the supraclavicular space air would bubble up upon the removal of gauze pressure. This cavity was packed lightly with iodoform gauze and wound closed in anatomical fashion. About one-fifth of the thyroid was left on the right side while a complete thyroidectomy was performed on the left side.

Pathological examination showed that we had two distinct tumors from this patient, the one on the right being soft and the one on the left dense and hard. In brief there were two large nodular ovoid masses, one of which was soft and the other firm. The soft mass measured $11 \times 5.5 \times 5$ cm. The firmer of the two masses measured $8.5 \times 6 \times 6$ cm. It was imperfectly encapsulated and on section the cut surface was moist, pale gray mottled and streaked with bright red and various shades of yellow. Microscopically the soft tumor consisted of large irregular alveoli of eosinophilic epithelial cells provided with rounded nuclei and occasionally showing mitotic division. The cells were often vacuolated and there was a tendency for the formation of spaces between adjoining cells, these spaces being filled with colloid. There was very little stroma and the tumor alveoli were intimately attached to wide thin-walled blood-vessels. In striking contrast with this picture the hard tumor mass showed occasional thin-walled thyroid alveoli in a densely fibrous matrix which contained spindle-shaped, irregularly stellate cells of very bizarre appearance. These cells were basic staining with reticulated cytoplasm and large irregular nuclei. Their number as well as their size varied greatly in different places in this scirrhous growth. Mitotic figures were fairly numerous and multiple metastases were observed. Areas of necrosis occurred in this part of the growth. Pathological diagnosis, adenocarcinoma of thyroid, right, scirrhous carcinoma of thyroid, left.

On the evening of the day of operation patient had a well-defined emphysema over the anterior chest and neck. This gradually subsided and at the end of thirty-six hours had completely disappeared.

The gauze packing in the supra-clavicular fossa was gradually removed and was entirely out of the wound on the fifth day. Patient made an uneventful recovery and was discharged, November 13, 1926, eighteen days after operation.

It is interesting to note that the left-sided mass apparently had its origin from the right, yet on the right side there was a typical adenocarcinoma and on the left side a scirrhous carcinoma. From an anatomical point of view it is interesting also to note that the left-sided mass passed outward and downward beneath the carotid artery and jugular vein, a very unusual anatomical finding.

II ADENOMA OF THYROID—STRUMA NODOSUM—MALIGNANT

DOCTOR HEYD also presented a woman, age thirty-five years, single, stenographer, who entered the New York Post-Graduate Medical School and Hospital, October 29, 1926 complaining of goitre of five years' duration. The patient states that about five years ago she began to notice an enlargement in the right side of neck in the region of the thyroid gland. This has very slowly increased in size and is entirely without symptoms. On physical examination there is a glandular mass at the site of the right thyroid gland,

freely movable, about five cm in diameter. Operation was performed October 29, 1926, under ethylene gas anaesthesia and a typical resection of the right lobe of thyroid and portion of isthmus carried out. On gross examination there are two pieces of thyroid tissue, one flattened and roughly elliptical in form measures $5 \times 3.2 \times 1.5$ cm. The other is a lobulated mass one end formed by a soft ovoid nodule measuring $5.2 \times 3.2 \times 3$ cm. To the centre of this is attached a small flattened mass of tissue $3.5 \times 3 \times 1$ cm. The combined weight is 47 grams. The smaller piece of tissue on section shows reddish fleshy thyroid tissue in which are embedded projecting yellowish-gray, semi-translucent nodules 1 cm in diameter. The centre of one of these nodules has been reduced to an irregular shaggy cyst. Section of the larger mass shows the ovoid lobe to be composed of two definitely encapsulated tumors. One measuring 3.2 cm in diameter, bulges above the cut surface, is soft grayish-yellow and mottled with red. Above this is a somewhat smaller tumor with central cystic softening. In the adjoining mass of thyroid tissue is a less definitely demarcated lobular tumor nodule 2 cm in diameter.

Microscopically sections from various portions of the tissue show a moderately variable structure. Everywhere there are colloid-containing alveoli in the thyroid lobules, but these alveoli are quite variable in size. Many of them are very small. Their lining epithelium consists of rather tall cells and in the lining epithelium there are occasional distinct mitotic division figures. Many of the alveoli are solid without colloid. The colloid itself is vacuolated and stains rather poorly. At the capsule one sees solid groups of epithelial cells extending into the fibrous tissue. These groups appear compressed but nevertheless the cells composing them are relatively large and their cytoplasm takes faint tinge of hematoxylin. There are numerous lymphocytes in the connective tissue not only of the interlobular septa, but also abundant within the lobules themselves. In one portion the stroma is very oedematous with well-defined thyroid alveoli scattered in it. The rapid growth is indicated by the presence of mitotic division figures, the abnormal staining of the epithelial cells and the poorly formed colloid as well as the presence of numerous collections of lymphocytes indicate a very profound disturbance of structure in which growth activity of the epithelial cells appears to be the essential feature. The transformation appears not to warrant an unqualified diagnosis of carcinoma, but at the same time the growth activity indicates a definite malignant tendency. Pathological diagnosis, multiple malignant adenomata.

The post-operative convalescence was uninterrupted and patient was discharged from the hospital, December 4, 1926, six days after operation.

Comment—This patient had no signs of hyperthyroidism and had simply a freely movable adenoma, yet the histological examination revealed multiple malignant adenomata, the diagnosis being made upon the marked cellular metaplasia with the high degree of mitoses of the specimen.

III ADENOMA OF THYROID—STRUMA NODOSUM—BENIGN

DOCTOR HEYN also presented a woman, age forty-three years, married, who entered the Post-Graduate Medical School and Hospital, November 9 1926, complaining of swelling of the neck, tachycardia, nervousness and weakness. About eighteen years ago she noticed a swelling in the neck which has gradually increased in size up to date. About two years ago noticed an increasing frequency of pulse rate and a general weakness, but without any loss of weight. She has also complained of increasing nervousness without any apparent cause. The patient has had three basal metabolism

tests, all of them plus, with an average of plus 24. On physical examination the patient is obese, with an irregular enlargement and deformity of the thyroid gland. The pre-operative diagnosis was adenomata of thyroid, with moderate hyperthyroidism. There was no history of iodine administration. The patient was operated upon on November 10, 1926, under ethylene gas anaesthesia. Operation findings were: The thyroid gland is entirely replaced by multiple adenomata involving the both lobes and isthmus. Many of the adenomata are degenerated into cystic hemorrhagic masses. The right lobe is approximately $10 \times 7 \times 10$ cm. The left is 15 cm in length, 10 in depth and about 7 in transverse diameter. The left side is completely substernal with pressure upon the trachea and adjacent soft parts. Operation consisted of typical collar exposure with resection of the right lobe from above downward, leaving about one-fifth of the degenerative tissue at the superior pole together with a small remnant of thyroid tissue on the posterior capsule. A bridge of fairly normal thyroid tissue was left across the trachea. On the left side the tumor mass was resected from above downward and about seven-eighths of entire lobe and adenomatous tissue removed. Haemostasis was assured and the wound closed in anatomical fashion without drainage. Microscopically the sections from various parts of the tissue showed considerable variation in structure. In some places there were thyroid lobules made up of colloid-containing alveoli fairly regular in size, but in these portions there were collections of lymphocytes in the fibrous stroma and there was an evident increase of connective tissue, especially around the lobules. All but the smallest alveoli contain colloid in these portions. The lining epithelium was low columnar or cuboidal in type. In some places the fibrous septa were one-half to one mm in thickness. Sections of one piece showed a much more marked alteration of structure. Here the epithelial cells formed very small alveoli without colloid or occurred as small clumps of cells in an edematous stroma. Well-formed thyroid alveoli were not found in this portion at all. It presented a thin fibrous capsule at the periphery which appeared to be respected everywhere by the epithelium. A brief search for mitotic division figures was negative. Pathological diagnosis, multiple adenomata of thyroid gland with one quite atypical adenoma, the structure of which suggests pre-malignant tendency.

Post-operative convalescence was normal. Patient was discharged from the hospital, November 21, 1926, twelve days after operation.

Comment—The histological examination here showed a condition of multiple adenomata of the thyroid with cellular metaplasia but an absence of mitoses. It is interesting to speculate whether the type of thyroid histology had been influenced by the co-existing hyperthyroidism.

IV ADENOMA OF THYROID—PERFORATION OF OESOPHAGUS

DOCTOR HEYD also presented a woman, age sixty years, who entered the New York Post-Graduate Medical School and Hospital, April 13, 1921, complaining of tumor of the neck. For the previous ten years the patient had noticed a gradual increase in the size of her neck. This was unaccompanied by symptoms up to three months before she entered the hospital, when she began to have some difficulty in breathing and swallowing and a sensation of constriction in the neck. On physical examination the patient showed a cystic type of goitre, more pronounced on the left side, extending beneath the clavicle. She was operated upon April 14, 1921, under ether anaesthesia and a typical bilateral resection performed. On the left side the tumor was firmly adherent to the trachea and to the muscular tissues behind the thyroid cartilage. During the operative procedures it was not apparent

that there was any perforation in the œsophagus. Thirty-six hours after operation patient had a temperature of 104.8° and pulse of 150. Under the impression that we had a condition of post-operative hyperthyroidism, the dressing was taken down and the wound partially opened with the escape of about thirty cubic cm of thin, yellowish fluid. A rubber tube drain was then inserted and at the end of forty-eight hours the character of the discharge assumed a more purulent appearance. On the fourth day water taken by mouth passed out the goitre wound. A duodenal tube was inserted and everything by mouth interdicted. The patient was fed entirely through the duodenal tube for eight days, or from the fifth day to the thirteenth day after her operation. During this period the cervical discharge was diminished to a small amount of mucoid material. The temperature became normal on the ninth day after operation and the patient was allowed up in a chair on the tenth day. During the eight days that the duodenal tube was in place the patient had no disturbance except a slight complaint of "phlegm" in the throat. At the end of eight days the duodenal tube was withdrawn, but it was found that the patient still had an œsophageal fistula because on drinking water a small amount came through the wound. The duodenal tube was reinserted and left in place until the twenty-third day after operation or an additional eight days when the tube was withdrawn and the patient was fed by mouth. The œsophageal fistula remained permanently closed. The patient was discharged from the hospital twenty-seven days after operation and except for a slightly increased scar at the original point of thyroid drainage revealed nothing noteworthy as the result of the œsophageal leakage. From the fourth day after operation until the twenty-third day after operation the patient had nothing by mouth and in all the duodenal tube in place sixteen days with an interruption of one day but without oral feeding. The disturbance from the duodenal tube was slight and a rather marked œsophageal fistula closed spontaneously in sixteen days. The patient's nutrition suffered some depreciation during the regime of duodenal feeding as the amount of nutrition and the variety of dietary articles that could be introduced through the duodenal tube are distinctly limited.

Comment—This patient has remained perfectly well to date.

V BONE METASTASES FROM ADENOCARCINOMA OF THE THYROID, SIX YEARS AFTER THYROIDECTOMY

DOCTOR HEYD also reported a case of adenocarcinoma of the thyroid operated upon June 2, 1919, at the New York Post-Graduate Medical School and Hospital. The patient was a man, at that time fifty-five years of age, who was seen in consultation for marked dyspnoea. The patient had been complaining of enlargement of the thyroid for the previous five years, the last three of which had been associated with a progressive and continuous difficulty in breathing. For the last year had noticed a change in his voice and at the time of examination could speak only in a whisper. In addition, the patient had a marked hacking cough throughout most of the day and night. On examination the patient showed a bilateral enlargement of the thyroid with mass extending down beneath the sternum. X-ray examination revealed a large retrosternal goitre. Under ether anaesthesia on June 2, 1919, a complete thyroidectomy was performed. Very little technical difficulty was encountered in removing the substernal mass $10 \times 5 \times 6$ cm., and weighing 218 grams. The patient made an uneventful recovery and was discharged on the eleventh day after operation. Microscopically the tumor consisted of closely packed columns of epithelial cells without colloid and with only very slender threads of connective tissue between them. Such closely packed

columns made up large areas 2 to 10 mm in diameter of practically solid epithelial tissue. Mitotic figures were present in the epithelial cells, and, in places, necrosis and hemorrhage. Pathological diagnosis, thyroid adenocarcinoma.

After leaving the hospital the patient, during the next year, submitted to three complete series of X-ray treatments and regained his weight, and was able to return to his duties as Inspector of Police, and aside from a permanent hoarseness was in every way clinically cured. The patient enjoyed uninterrupted good health until September, 1926, when he returned complaining of pain in the lower extremities, edema of both legs, loss of weight and a tumor in the right thigh, upper third, inner side. His history at this time was that two years ago he noticed a small lump on the inner side of the right thigh and began to complain of weakness of the legs, with pain, particularly on the right side. At this time sugar was found in his urine and he was treated intermittently for glycosuria. On examination the patient was cachectic and appeared an extremely ill man. To the inner side of the right femur was a mass the size of a foetal head at term, somewhat movable and did not appear attached to the bone. On rectal examination a mass was felt to the right of the rectum occupying the true pelvis. The diagnosis at this time was vertebral and spinal metastases with pelvic tumor, secondary to adenocarcinoma of the thyroid. X-ray examination by Doctor Meyer at the Post-Graduate Hospital on October 1, 1926, showed areas of destruction involving the inner margin of the brim of the true pelvis on the right side with further metastatic like areas in the right pubic bone and ramus extending toward the ischium, with a further small focus of rarefaction in the left pubic bone. Further evidence of metastasis also appeared to exist in the left femur below the trochanters. Rontgenological diagnosis, metastatic malignancy.

Comment—At the operation there was nothing about this tumor to suggest malignancy unless it were the unusual hardness and density of the mass. Following the operation the patient was submitted to rather intensive and extensive X-ray therapy. He enjoyed almost uninterrupted good health for seven years, the last two years of which, however, were undoubtedly characterized by the development of his vertebral and pelvic metastases. At the present time he is being treated palliatively with X-ray for his pain.

DR HOWARD LILIENTHAL referred to Doctor Heyd's second patient as to whether or not the patient should be told that the growth he had removed from her neck was malignant. He thought that it was not necessary to give this information to the patient herself but that her family should have it. He believed that many of these malignant tumors of the thyroid are slow to recur and that this one might not recur for many years. In one of his first cases of cancer of the thyroid he removed what was apparently an adenoma, it was later reported from the laboratory to be an adenocarcinoma and the patient was sent home to die. Three years afterward he was perfectly well. Another case, also a malignant adenoma of the thyroid with extirpation and subsequent myxœdema apparently made a perfect recovery, he had followed this case for at least ten years. When the patient stopped taking thyroid during an acute illness, there was an acute return of the symptoms of myxœdema, but they disappeared on the resumption of the thyroid therapy. Doctor Lilienthal said he did not think cancer in any other part of the body would give so much hope that the patient might go on for years without recur-

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rence, as that of the thyroid. In another case of malignant adenoma of the thyroid, on which he had operated, he removed only the diseased part. The patient apparently recovered but later had recurrence below the jaw. The case went on with X-ray treatments for six years and then the patient died. Many of these cases are of extremely slow malignancy, and Doctor Lilienthal expressed the hope that this young lady would never have any further trouble with her thyroid.

DR JOHN ROGERS said that he had operated on many of these malignant tumors of the thyroid and he believed it difficult to make a diagnosis beforehand. When a tumor of the thyroid has the appearance of an adenoma, but can be enucleated without rupturing the capsule, the prognosis is extremely good. He believed the prognosis in the case of this young woman presented by Doctor Heyd was good.

DR WALTER A. SHERWOOD said he had observed a case on which he had operated on the assumption that it was simple adenoma. A very incomplete operation was done, merely a resection of one lobe of the gland, but the laboratory reported malignancy. This was two years ago. The man's toxic symptoms disappeared after the operation and the remainder of the thyroid has decreased in size and there is no sign of recurrence. In view of this Doctor Sherwood felt he could substantiate the opinions of Doctor Lilienthal and Doctor Rogers.

In closing, DOCTOR HEYD said he was moved to present these cases of adenoma to emphasize the inherent danger of leaving adenomata of the thyroid unremoved. There is a well-evidenced tendency for some of them to show changes that lead to grave hyperthyroidism. Again, the continued presence of an adenoma with increasing growth induced sooner or later some degree of pressure symptoms and, finally, all adenoma were potentially malignant. The fact that the first case had carried a tumor on the right side of her neck for forty years and then had a malignancy develop was proof that an adenoma, left sufficiently long, had in it the possibilities of cellular metaplasia leading to malignancy. In the second case—struma nodosa malignum—Doctor Heyd was not prepared to inform the patient that she had a malignant goitre, nor would he submit the patient to X-ray or radium therapy because the adenoma being well encapsulated offered a reasonably good prognosis. However, he agreed with Doctor Lilienthal that some member of the family should be apprised of the possibilities of later manifestation of malignancy.

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DR HAROLD E. SANTEE presented a young woman, age nineteen years, who was referred to Bellevue, Second Surgical Division, by Dr. John Rogers, October 5, 1926. She gave a history of increasing nervousness, insomnia, vasomotor instability as indicated by flushing and sweating from July, 1925, to January, 1926. At this time, enlargement of the thyroid was apparent. Severe headaches, tremor, tachycardia, progressive weakness and loss of weight were apparent in spite of increased appetite and food consumption, and from January to June, 1926 most of her time was spent in rest at home and in bed in an effort to overcome her trouble. Palpitation, tremor, extreme

nervousness, precordial pounding of the heart, diarrhoea, weakness and a loss of weight of twenty-five pounds in twelve months briefly describe her condition during the summer. Exophthalmos was moderate and the thyroid was diffusely and greatly enlarged with all the local characteristics of a true hyperplastic gland. Under a very careful regime during the month prior to admission to Bellevue, some weight was regained but the exact amount was uncertain.

The excitement of hospitalization increased her pulse rate to 140 and on October 7, 1926, her basal metabolism was plus 62 per cent. Lugol's solution, 10 mms, t i d, was given with obvious benefit subjectively and with considerable benefit objectively for the following nine days. Her metabolism on October 14, 1926, was plus 48 per cent. Although clinical improvement was fairly marked, this particular case as an operative risk was viewed with apprehension by the reporter, not so much because of any laboratory test as by reason of that intangible feeling or "hunch" that is apt to result from a close observation of an individual case of Graves' disease. Perhaps the main factor in this was a close observation of the soft fulness of the pulse and its irritability in response to mild mental and physical stimuli.

For this reason, a ligation of both inferior thyroid arteries under local anaesthesia was done on October 16, 1926, not for any therapeutic effect, but as an aid to later resection. No undue reaction resulted and Lugol's was resumed after three days. On November 6, under gas, oxygen anaesthesia, a resection of both lobes was done, excising about three-fourths of each lobe. The gross findings and the microscopic examination were characteristic of Graves' disease. The procedure, however, was too long for this individual and the operator is frank to say that he overstepped the threshold of safety in this case. This was realized, however, and in addition to the usual post-operative medication of these cases, three doses of an aqueous thyroid extract were given intramuscularly, mms 20, q 2 h. Bromides in rectal tap and morphine were also used. Approximately twelve hours after operation, the temperature began to rise and she grew gradually more and more restless. Sixteen hours after operation, the temperature had risen to 107 degrees. Quoting from the report of the House Surgeon (Doctor Heim), who stood by the patient through the night hours: "Patient was in a wild, delirious, uncontrollable state. Pulse was so rapid it could not be counted. Every measure possible was administered to bring down temperature, sponge baths, ice packs, exposure to draughts. A total of a grain of morphine had been given in twelve hours which seemed to have no effect. The most dramatic effect was then observed after the administration of 30 minims of aqueous thyroid extract intravenously. Five minutes after this administration, patient had changed from a raving maniac to complete quietness. Pulse had dropped to within countable limits and was around 120. Quality had completely changed. Whereas before it was extremely rapid, thready, and weak, now it was full, bounding and strong." Three such intravenous doses were given at two-hour intervals. Temperature dropped to around 102°. A second exacerbation of toxicity occurred twelve hours later which was also alleviated by similar dosage, following which the patient was continued on intramuscular dosage of fifteen minims twice a day for three days. The neck wound was infected, probably due to the extreme muscular activity and sweating combined with the various therapeutic measures used at the height of her acute toxæmia. This, however, subsided gradually and following the first three days post-operative, the patient progressed well until her discharge from the hospital, November 21.

This case was shown as illustrating the use of what seems to be an

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effective therapeutic agent in that occasional tragic sequence to operation in this disease. Two months ago, Dr. John Rogers reported in *Surgery, Gynecology and Obstetrics*, similar striking effects in three cases. Personally, the reporter had seen three cases in which he feels that life has been saved by the use of this aqueous thyroid extract. The agent itself is an aqueous extract of fresh pig thyroid from which all coagulable material has been removed and the resulting extract concentrated down to contain a definite amount of iodine to the cubic centimetre. Its employment rationally seems to be explained on the grounds that it supplies a fairly normal utilizable thyroid extract to a patient suffering from either a complete suppression of the normal secretion or a highly toxic secretion, perhaps both. In the cases in which he had used it, no toxic effects have ever been noted. However, it does not work in every case but is to be considered a possible measure of relief in those tragic cases like the above.

DR. JOHN ROGERS said this case was a very interesting illustration of the probable pathologic physiology which underlies these disturbances. One cannot think of them as the result purely of an excess of toxic secretion in the thyroid. At autopsy these thyroid glands are found to be almost solid with practically no colloid in the alveoli. Instead the alveoli are represented by disintegrating masses of cell tissue. It is hard to believe the gland has secreted anything like normally. These cases of toxæmias occur quite rapidly. The speaker had been successful in giving the "thyroid residue" in many of these post-operative toxæmia cases and he found it a valuable thing to have at hand. Many of these cases become suddenly alarmingly ill during the operation, and an injection of the thyroid residue (20 minims) will slow and strengthen the heart action.

Going back to the pathologic physiology. It is well known that the feeding of any thyroid product increases the blood sugar. The acute toxæmia and chronic toxæmia can both be relieved by glucose in a solution of 50 per cent. It has to be chemically pure and can be given in post-operative toxæmias once in twenty-four hours. This glucose seems to act beneficially in all the cases, no matter what the blood sugar content. In chronic toxæmia, with restlessness and nausea, after every dose of 20 c c of 50 per cent glucose solution, the patient goes to sleep and stops vomiting, and in many of these dangerous disturbances the addition to the glucose of the thyroid residue seems to intensify the beneficial effects of the glucose. This non-coagulable extract, by the way, does not in these cases accelerate the pulse rate.

Apparently, therefore, the thyroid residue makes the glucose more available for assimilation by the nervous system. Hence, in the speaker's opinion, it seems probable that normally the thyroid product helps the nervous system to absorb glucose, that in hyperthyroidism there is some change in the character of the thyroid product which interferes with this absorption, that there may be an excessive quantity of secretion, but the quantity is far less important than the quality, that in the severe and more or less acute toxæmias the quality of the product is so poor as to be entirely incapable of providing the nervous system with sugar, that in the very acute post-operative toxæmias the thyroid product, because of the traumatism to the gland, is for

a time entirely absent and the ensuing restlessness and delirium are evidences not of too much poisonous thyroid product, but of a sudden and complete failure of an already half-starved nervous system to obtain any more sugar. This thyroid residue is admittedly an imperfect substitute for the normal product of the gland, but it is the best now obtainable and it undoubtedly bridges over the interval until the injured gland can at least partially functionate.

DR HOWARD LILIENHAL asked if the addition of insulin to the administration of glucose and thyroid residue would be of benefit in these cases of lowered natural production of thyroid secretion.

DR JOHN ROGERS replied that the use of insulin in these cases may be dangerous. That might seem to be a curious contradiction in these cases of toxæmia in which it is necessary to administer 10 c c of glucose every 24 hours to keep the patient alive. But in one case he had tried the experiment of giving 10 units of insulin after the glucose and the patient became delirious, had convulsions and rapid rise of temperature. She pulled through, but if she had had more insulin it was the speaker's belief that she would have died.

The thyroid residue, by the way, is the trade name for an aqueous extract of the thyroid from which all coagulable material has been removed. This non-coagulable liquid is then concentrated so as to contain a definite amount of iodine.

BILATERAL MASSIVE COLLAPSE OF LUNG

DR HAROLD E. SANDLE remarked that three years ago, Doctor St. John read a paper before this Society on massive collapse of the lung. Since 1908, when Pasteur described this as a true clinical entity, the work of Bradford on gunshot wounds of the thorax, and particularly, the careful reviews of Scott and Churchill last year with the report of cases from Peter Bent Brigham and Massachusetts General Hospitals, together with the previous reports of F. A. C. Scrymger, leave little doubt as to the frequent occurrence of this condition but considerable doubt as to its true significance. Personally he had held a somewhat sceptical attitude in regard to any real significance attached to this condition and had viewed it as an interesting post-operative clinical finding only, but in the light of the autopsy findings here presented, he had changed this opinion and now feels that it may be much more significant than he realized. These cases with two other autopsy cases will be published in full by Doctors Bergamini and Shepard of the Second Surgical Division at Bellevue and he wishes to acknowledge the courtesy of these men and of Dr. Charles Norris of the Medical Examiner's Office in granting him the privilege of presenting these specimens. Only brief outlines will be presented.

CASE I—M. L., age forty-four, died on the operating table on September 24, 1926, just at the end of a hysterectomy and appendectomy. General condition had been good previously and also during the operation up to the time of a complete cessation of respiration. The usual methods of resuscitation plus the pulmotor and adrenalin into the heart were unavailing. Autopsy

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showed massive collapse of left lung and collapse of all but one lobe of right lung. No bronchial obstruction was found and the only significant additional finding at post-mortem was a moderate œdema of the larynx.

CASE II.—The gross specimens of this case are presented. The history is surrounded by conflicting statements. From these it is gathered that sudden death occurred in an office, presumably in connection with tonsillectomy, but septic abortion was diagnosed. No odor of anæsthesia was present. Collapse of the lung was massive on both sides with no bronchial obstruction made out. The fresh gross specimens of each case can be held in the cupped hands. No hardening or shrinking fluid has been used on the specimen presented. The microscopic preparations in both cases, as examined by Doctor Symmers, reveal a tissue which it is difficult to recognize as lung, resembling, rather, a solid organ. This appearance is found to be due to complete atelectasis of the pulmonary alveoli, the epithelial cells of which are closely packed together, having lost entirely their normal alveolar arrangement. The individual cells are swollen, certain of them being obviously hydropic, and the cell outlines are rather indistinct. The bronchioles are also collapsed for the most part, many of them being represented merely by circular clumps of cuboidal cells. The capillaries, arterioles and venules, on the other hand, are all uniformly dilated and filled with blood, producing almost an angiomatic appearance in certain areas. This constitutes the most characteristic feature of the histology of the condition.

In the various explanations advanced as to the cause of this condition, paralysis of the muscles of respiration as outlined by Pasteur cannot constitute the whole cause. Mechanical plugging of the bronchus certainly does not explain all cases. The best explanation seems to be that there is some reflex disturbance which causes a constriction in the air passages, probably affecting the small bronchioles, not dependent originally on infection and acting on both lungs to some extent. In this explanation as outlined by Scott, the following possibilities present themselves:

- (1) Vasomotor disturbance—dilatation and stasis, (2) bronchiole spasm, (3) swelling of the mucous membrane similar to angioneurotic œdema.

In the specimens presented are factors seeming to support all of these possibilities to some extent, but the true causative mechanism is still a matter of conjecture.

DR HOWARD LILIENHAL had noticed during the War that there sometimes occurred after a gunshot wound in the chest what was called traumatic atelectasis, but he believed this was the same thing that happens in massive collapse of the lung. In the unopened chest the alveoli become filled with cells and the blood-vessels become engorged, because actual collapse could not occur. He was glad to hear there was no bronchial obstruction in the cases that came to autopsy. From what Chevalier Jackson said the speaker had had an idea this condition was caused by the plugging of the bronchial branches because he has reported cases where this plugging was removed and the collapse disappeared. Doctor Lilienthal had always believed it was due to spasm of the lung itself due to some unknown cause. He had suggested to the Surgeon General that experiments be made to find out the cause of this catastrophe, by stimulating the nerve centres. He had talked to Scrvinger in Montreal and had asked him what was thought of Jackson's theory and he

said he did not believe it fitted all cases. Here is Doctor Santee's case in which a full post-mortem was made and no obstruction of the bronchi found. This is a very important contribution.

SPONTANEOUS DISLOCATION OF A SUBSTERNAL GOITRE

DR WILLIAM BARCLAY PARSONS presented a woman who was twenty-five years of age in May, 1924, at which time she complained of nervousness, palpitation and goitre. Ten years before admission she began to have a choking sensation with nervousness, palpitation and tremor of her hands. Insomnia appeared shortly. Three years after onset she extended her neck violently and had a feeling that something moved in her neck. Simultaneously the goitre appeared and the choking sensation disappeared never to return. She had a +50 basal metabolism, tachycardia, nervousness, tremor and insomnia and was operated upon with a good recovery.

He had never heard of this occurrence, namely a spontaneous dislocation of a substernal goitre.

LATE POST-OPERATIVE RECURRENT NERVE PALSY

DOCTOR PARSONS presented a man who was fifty-two years of age in March, 1924. He came to the hospital with a complaint of dyspnoea for ten years which had been gradual in development without cough or palpitation. Dyspnoea was markedly increased with the slightest respiratory infection but there had been no toxic symptoms.

On physical examination he presented curvature of the spine thought to be due to an injury in infancy and a soft boggy swelling just above the right clavicle, the mass apparently passing down into the thorax. On X-ray there was a substernal shadow, a narrowed trachea that was displaced considerably to the left and an apparent downward displacement of the aortic arch. Laryngoscopic examination by Doctor Babcock showed a marked laryngeal displacement to the left without any vocal cord paralysis. Basal metabolism was ± 0 .

Operation was done under local with the Pemberton technic. A 9 cm \times 5½ cm mass was removed from the right side. The left lobe was small and soft. He made an excellent recovery and was discharged on the tenth day with distinct improvement in his respiration. His voice was perhaps a little hoarse but not more than many individuals on the tenth post-operative day and there was a distinct vocal quality to it.

He went up to Burke and after about a week, on the seventeenth or eighteenth post-operative day, his voice altered in the afternoon and by night he was almost aphonic. He had no pain and no cough. He returned to New York about a week later and Doctor Babcock on examination this time found a partial paralysis of the right vocal cord. At follow-up at six months his voice had returned, but he was hoarse. Laryngoscopy showed the right cord still paralyzed, the left beginning to over-act. At twelve months his voice was almost as good as before operation and Doctor Babcock noted full compensation by the left cord. At twenty months he returned from abroad, having put on considerable weight, so he began dieting under Doctor Bauman, and from November, 1925, until June, 1926, by great faithfulness, had reduced twenty-five pounds and was in much better shape. At twenty-seven months the result was very satisfactory. He was breathing easily and his voice was, to his mind, as good as before the operation.

It is rather unusual for a recurrent nerve palsy to appear at this interval. In the reported cases there was either a section at operation in which the paralysis came on immediately or else there was a contraction of scar tissue.

ADENOMA OF THE THYROID

which did not cause the palsy until several months, usually four to six. I imagine that this man's nerve was caught in the shift of planes which took place and became angulated or constricted earlier than usual. It is hard for me to believe that his nerve was sectioned at operation inasmuch as local was used and he talked very well during and immediately following the operation.

Frazier, of Philadelphia, discussed before this society last year his results in nerve repair in these cases. In view of this man's reasonably good voice it does not seem worth while now to advise this procedure.

ADENOMA OF THE THYROID

DR WILLIAM BARCLAY PARSONS read a paper with the above title for which see page 107.

DR HENRY W. CAVE recalled having seen a young man who had yawned rather heavily and had immediately experienced the sensation of choking to death and was blue in the face. He had dislodged a large sized substernal adenoma of the isthmus. He was taken to the hospital and operated on under local anæsthesia, and it was found that he had an enlarged thymus gland—a status lymphaticus. Three months later there was acute œdema of the thymus which may have had something to do with the pushing up of the adenoma of the isthmus.

DR CHARLES G. HEYD said that the hyperthyroidism of adenoma behaves differently clinically from the hyperthyroidism of Graves' disease. There is first of all the difference in the age grouping of the two conditions, and secondly, in the clinical manifestation. He believed that the hyperthyroidism of Graves' disease was really a dysfunction in that there was some inherent change in the chemistry of the secretion of the thyroid in Graves' disease that was essentially different from the secretion of the thyroid in adenoma. Most of the patients with an adenoma that develop hyperthyroidism have had a tumor of the thyroid for long periods of time, so long in fact that they had accepted the goitre as a matter of fact and presented themselves in the dispensary, or at consultation, for a heart complaint or a tachycardia, or other symptoms of hyperthyroidism.

In regard to iodine medication Doctor Heyd was impressed with the fact that a great deal of harm was being done by the wholesale administration of iodine. His own cases of adenoma that had been treated with iodine had been more dangerous from an operative point of view than an ordinary uncomplicated case of Graves' disease. Apparently, iodine in an adenomatous goitre, was fraught with two dangers, first the danger of converting a non-toxic adenoma into an adenoma with hyperthyroidism and secondly, if given in a hyperthyroidism of adenoma it was very apt to produce a "fixed" hyperthyroidism. In other words a hyperthyroidism that did not respond to rest and medical therapy or the measures that were used as a preliminary to operative intervention. The cases of fixed or iodine hyperthyroidism offered a greater operative risk than did the simple cases of hyperthyroidism that have not been given iodine. If he assumed the correctness of Plummer's

theory of iodine in Graves' disease it was indicated only for a short period of time for the purpose of lessening an operative risk and in his opinion was about equivalent to a bipolar ligation

Doctor Heyd wished to draw attention to the routine post-operative treatment of goitre cases that consisted in the administration by rectum of 500 cc of a 10 per cent glucose solution with 4 cc of Lugol's solution every eight hours. Most of the cases of hyperthyroidism that had been operated upon by him were done under rectal anaesthesia with the patient going to sleep in her own bedroom and avoiding thereby all of the exciting causes incident to a trip to the operating room. The surgery of adenoma of the thyroid was, in the opinion of Doctor Heyd, different than the surgery of Graves' disease. If Graves' disease represented a hyperplasia then the operative indication was for a removal of a major portion of the thyroid in order to diminish the secreting units of the thyroid by just the amount represented by the tissue removed. On the other hand, the surgical indication in an adenoma was the removal of a tumor growing within an apparently normal thyroid gland. That this condition seemed to be correct was borne out by the fact that a case with an adenoma with hyperthyroidism usually recovered much more quickly after surgical intervention than did the patient with the hyperthyroidism of Graves' disease. In other words, removal of the offending adenoma of the thyroid brought about a more prompt and a more complete cure or relief from symptoms than did a subtotal resection of the thyroid in the cases of hyperthyroidism of Graves' disease where the recovery was more delayed.

DOCTOR PARSONS, in closing the discussion, said that he agreed with Doctor Heyd in regard to the distinction between the hyperthyroidism of adenoma and that of Graves' disease, but it is hard to prove. In reference to iodine, although he felt that some of these cases were stimulated to activity by the injudicious use of iodine, one must consider this point from the time standpoint in that these patients have carried a goitre for a long time. Something happens which makes them go to a doctor. This may be the beginning of their hyperthyroidism. He gives them iodine and toxic symptoms develop. Is that coincidence, and has the time of the iodine therapy overlapped the development of the hyperthyroid symptoms? If that is so, the iodine therapy was of no importance in the induction of hyperthyroidism, but it seems to happen too often to be a mere coincidence.

Stated Meeting Held January 12, 1927

The President, DR WALTON MARTIN, in the Chair

PEDICLE GRAFT FOR OS CALCIS COVERING

DR RALPH COLP presented a man, age thirty-five years, who was admitted to the Surgical Service of the Beekman Street Hospital, November 8 1925. On the day of admission, when attempting to stop an elevator, he missed the rope and inadvertently caught his right foot between the floor of a moving elevator and the floor of the building, crushing the heel.

PEDICLE GRAFT FOR OS CALCIS COVERING

Examination disclosed a transverse lacerated wound of the right heel down to the tendon Achilles, really a partial avulsion of the heel. The Rontgen examination of the right foot showed an incomplete fracture of the os calcis without displacement. Under anæsthesia the wound was thoroughly irrigated with saline solution for about fifteen minutes and then cleansed with alcohol and ether. After thorough debridement, the laceration was sutured with silkworm gut and silk, and the wound was dressed with vaseline gauze. Dressing a few days after operation revealed that the wound was not infected, but that the lower flap of skin covering the heel, that is an area of about 2 inches x 3 inches, had become black and gangrenous. Within the one week, the necrosis of the heel had progressed so that a circular area about 5 inches in diameter was involved. The underlying granulations, upon removing the slough, however, were fairly clean and in the centre, bone was exposed.

Four weeks after the initial trauma, the wound surface which measured about five by four inches, appeared clean, the granulations red and exuberant, and conditions seemed satisfactory for a pedicle graft.

December 10, 1925, a pedicle graft was transferred to the right heel, employing the following technic. The area of the right heel was thoroughly scrubbed with green soap and water, followed by alcohol and ether, and since this procedure caused bleeding, the granulating area was covered with hot towels and pressure applied by hand of an assistant. A full thickness pedicle graft was cut in the region of the left thigh measuring about 4 inches in length, and about 5 inches in width. The pedicle ran parallel to Poupait's ligament. The thickness of the graft included all tissues between skin and the deep fascia of the thigh. The denuded area which was caused by raising the skin flap was thoroughly covered with Thiersch grafts which had been removed from the anterior aspect of the right thigh. These grafts were held in place with paraffined gauze reinforced by moist gauze dressings. A sheet of rubber dam completely encased this dressing. This dam prevented secretions from the thigh reaching the area of the heel, and the secretions from the heel seeping into the dressings of the thigh. The right heel was then brought up to the anterior aspect of the left thigh where it rested on the rubber dam, and the free edge of the graft was sutured to the periphery of the wound of the heel with interrupted silkworm gut sutures for about one-half of the extent. In order to permit secretions to escape through the graft, it was perforated in several places with a Dakin-tube punch. The parts were then rendered absolutely immobile by a plaster spica, which was applied completely encasing the lower half of the body. The graft itself was covered with paraffined gauze and a sterile towel. Twelve days later the graft, which was completely viable, was incised at its base for a distance of about one inch on each side. There was free active bleeding from the distal part of the graft. The next day, under local anæsthesia, the flap was entirely divided and the free end sutured to the heel with interrupted silkworm gut. The plaster case was then removed and the area of the left thigh was dressed for the first time. It was found that all the Thiersch grafts had taken.

The patient was discharged January 5, 1926, with the heel completely cicatrized. He was warned because of lack of sensation in the graft to protect the skin from the shoe by means of a layer of rubber sponge. Wound remained completely healed until December 1, 1926 when because of the holiday rush, patient was forced to walk around most of the day and neglected to protect his heel with a rubber sponge resulting in a small ulcer which has since healed.

DOCTOR COLP also presented a youth of seventeen years who was admitted

to the Beekman Street Hospital, March 26, 1926. His history dates back to fourteen months before admission, when his right heel was crushed between the street pavement and the platform of a moving elevator. The wound, which involved practically the entire heel, never cicatrized completely, but left an ulcer about the size of a silver half dollar which did not heal in spite of the fact that it was dressed three times a week for over a year. When admitted to hospital he presented a sluggish ulcer about the size of a fifty-cent piece, lying practically on the posterior medial aspect of the right os calcis. The region of the right heel was replaced by dense scar tissue firmly adherent to the underlying os calcis. There was a deformity of the foot with a contracture of the flexors of the leg resulting in an apparent talipes equinus, although when patient walked, the gait was almost normal. The Rontgen examination of the foot showed an old complete fracture of the os calcis about midway through its body. This was healed with the posterior fragment turned markedly to the inner side, and that it was comminuted is indicated by a hole through the outer side of the bone. There was a rather large deforming callus present.

Inasmuch as the ulcer was placed almost directly upon the os calcis and surrounded by dense scar tissue, a pedicle graft seemed to be the only procedure which might effect a cure. Before this could be done, a bed of healthy granulation tissue to receive the graft had to be prepared. April 3, 1926, the ulcer was thoroughly curetted and a small part of the scar tissue about the os calcis was excised and about a dozen holes were drilled into the uncovered os calcis with the hope that granulations might spring up from the medulla and thus cover the bone. The leg and foot were placed in a plaster case in dorsal flexion. Ten days later the wound was clean and granulations were flourishing and beginning to cover in the bone. There was still a great amount of scar tissue surrounding the area of granulations. It took three subsequent operations before all the scar tissue had been excised and drill holes had been bored in the bone which was uncovered by the removal of the cicatrix. An X-ray picture of the heel did not disclose any infective osteomyelitis. About six weeks after his admission, the region of the heel as represented by the posterior portion of the os calcis, was covered with bright red granulated tissue and the conditions seemed favorable for a pedicle graft. Accordingly, on May 17, 1926, a pedicle graft was applied to the right heel for the large defect which involved the posterior portion of the heel, extending from its inferior margin up on to the region of the tendon Achilles for the extent of 5 inches. The transverse diameter of this defect was about 3 inches. The technic employed was similar to Case I.

Six days post-operative the graft was in excellent condition and the pedicle was partially divided one inch on each side. Good active bleeding occurred from the distal side.

Eleven days after the primary operation, the pedicle was completely divided. The area which had been covered with Thiersch grafts was dressed, all had taken. Three days later, the free end of the pedicle graft was sutured into place with interrupted silkworm gut sutures. Following this there was some sloughing of the graft, the granulating area resulting was covered with five small pinch grafts. The patient was discharged July 3, 1926, and since then the affected area has remained completely healed with an excellent functional result.

These cases were shown not only to illustrate the well-known technic of a pedicle graft and to show the practicability of covering the os calcis with

MEDIASTINAL SARCOMA

granulations derived from its own medulla, but to emphasize the importance of pedicle grafts in this region

The heel because of its anatomical location is made to stand the stress and strain of daily use, large scars, the results of trauma to this region are naturally poorly tolerated, and the resulting chronic ulcers produce total disability in the majority of cases. In wounds of the heel with a loss of substance a full thickness pedicle graft with an adequate supply of subcutaneous fat appears to be the ideal procedure. It should be remembered, however, that sensation is slow to return to the graft and that the heel should be adequately protected from the unsuspected irritation of the shoe until such time as the sensation returns and the skin has adapted itself to its new environment by the development of callus

TRAUMATIC RUPTURE OF POLYCYSTIC KIDNEY

DR JAMES N WORCESTER presented a man, forty-eight years old, who was admitted November 3, 1926, to the Beekman Street Hospital. Just before admission he had been run into by a truck, being struck in left flank. Immediate pain in right flank and right side of abdomen. When admitted he presented marked tenderness and rigidity in the right flank and right abdomen. Slight spasm left flank. Quite marked shock. He showed signs of internal hemorrhage. Catheterization produced pure blood. A rupture of the right kidney was diagnosed and an immediate operation was performed. The kidney was exposed by an oblique incision, on opening the capsule a large amount of blood escaped. On inspecting the kidney it was seen that an abnormal kidney was present. It was very large and studded with cysts and in many places was adherent to the capsule. The pelvis of the kidney was completely torn across and the kidney almost split in half. An attempt was made to tie the renal vessels, doubtful if this was successful. On account of profuse oozing, the cavity was packed with gauze.

Post-operative—Immediately following operation condition not very good, however, he responded to hypodermoclysis and proctoclysis. Following which convalescence was remarkably smooth. Packing removed on sixth day without hemorrhage and tube inserted. This was gradually shortened. Wound completely healed on discharge. For several days post-operative ran blood in urine and some white cells. Quantity always satisfactory. Specific gravity always low, 1008–1012.

December 1, 1926. Blood chemistry as follows: 20.6 mg urea nitrogen in 100 cc, 2.1 mg creatinine nitrogen in 100 cc. Phthalein test. Appearance in eighteen minutes—25 per cent first hour, 20 per cent second hour, total, 45. Urine amber, acid, 1010 clear, no casts. Present condition is satisfactory. The left kidney can be felt extending almost down to the spine of ileum.

MEDIASTINAL SARCOMA—TREATED BY COLEY'S FLUID

DR HOWARD LILIENTHAL presented a female aged four years who was brought to the Clinic of the Hospital for Joint Diseases March 21, 1924. The child had been apparently normal, had weighed nine pounds at birth, nursed for ten months, stood up at eight months, talked at ten months and walked at sixteen months, teeth at eleven to twelve months. The child had gained slowly in weight although there had been frequent green diarrheal stools but without vomiting.

At the age of five months the mother noted that its breathing was distinctly labored but the doctor could find nothing wrong with the lungs. For

two months there was respiratory disturbance but without cyanosis or other sign of deficient aeration. The child's color was pale and the heart's action often rapid. The mother stated that she noted a lump "on the right shoulder blade" at the age of about eight months and she took the infant to the Babies' Hospital, where an X-ray study was made. This was reported as showing "A large roughly quadrilateral dense shadow in the lower part of the right chest extending over the heart, also into the left chest and down over liver shadow. Right chest above this appears free from lung tissue (1). The right diaphragm appears adherent to the mass. The right chest is smaller than the left. The right bronchus not seen. Probably congenital atelectasis." This report was kindly furnished by Dr. Kenneth D. Nichol, Resident Physician of the hospital on December 16, 1926.

The mother refused to leave the baby but took it to the Lebanon Hospital, where the X-ray report made on April 30, 1923, was as follows: "Fluoroscopic examination of chest of Phyllis H. shows a dense shadow homogeneous in character, sharply circumscribed, ascending apparently from the lower mediastinum and projecting to the right. The mass is the size of a small orange, its left border projects slightly to the left of the median line and is overshadowed by the heart. The appearance is that either of a cyst or neoplasm ascending from the mediastinum. From its shape and age of the patient we are inclined to believe that it is very likely a cyst."

A puncture was made at the Lebanon Hospital which produced sterile bloody non-coagulating fluid. The Wassermann test and the usual blood and urine examinations failed to show positive indications of disease. Operation was suggested at this time, but the mother refused, and took the child home.

At twenty months of age tonsillitis developed and the patient was taken to Beth David Hospital, where rontgenological examination resulted in corroboration of the former findings.

March 16, 1924, when twenty-one months old, the child suddenly stopped walking because of weakness of the right lower extremity. This became rapidly progressive. At first she was able to stand, but the right foot turned out and she fell on attempting to walk.

When seen by Doctor Pollak at the Hospital for Joint Diseases, it was noted that the patient was a bright, well-nourished child without fever or pain. There was great weakness of the lower extremities, particularly of the right. There was total inability to stand because of paresis of both legs. There was a mass between the right shoulder blade and the spine with dulness upon percussion, breath sounds were exaggerated anteriorly. The blood examination revealed hæmoglobin, 42 per cent, red blood cells, 3,200,000, leucocytes, 14,000, polymorphonuclears, 42, small lymphocytes, 38, large lymphocytes, 13, transitionals, 1, eosinophiles, 3. Urine examination negative. X-ray studies by Dr. H. B. Phillips on April 14, 1924, resulted in the following report: "Cyst lower right chest. Pressure erosions spine and rib—and œsophagus is displaced anteriorly." On May 16 Doctor Phillips made another rontgenological study of this case. The final rontgenogram, which is shown herewith (Fig. 1), was by Doctor Jaches.

The child was first seen by Doctor Lihenthal, April 12, 1924, one month after she had stopped walking because of the constant weakness of the right hamstring muscles. At that time, both legs were flaccid and obviously paralyzed. There was a protruding subcutaneous mass covered with normal skin between the right scapula and the spine. It was firmly elastic. X-ray examination showed a large mass in the right chest extending across the

MEDIASTINAL SARCOMA

median line into the left chest above the heart (Fig 1) The opacity of the right side occupied the lower two-thirds of the chest and extended to the left above the heart where there was a large shadow There appeared to be partial erosion of the adjacent ribs posteriorly and also some erosion of the bodies of the neighboring vertebrae The child's condition was so good however, that it was hard to think of the case as one of malignancy

The patient having entered Mt Sinai Hospital, on April 15, Doctor Lilienthal operated, using at first local and then general anaesthesia He resected about one and one-half inches of a rib subperiosteally over the tumor

He then aspirated with a coarse needle a minute quantity of thick, bloody fluid The posterior mediastinum was then opened and the capsule of the tumor exposed

This was incised so as to admit the index finger

The wall was tense and the tumor rudely spherical

A large part of the contents was removed with the finger

It consisted of soft grayish-red neoplastic tissue

The total amount removed was a little greater than

the bulk of a golf ball

and the oozing cavity was packed with iodoformized gauze This gauze was allowed to protrude at the ends of the wound and the skin was closed with silkwool gut sutures The pleura was not entered The tumor was examined at the laboratory by Dr F S Mandlebaum with the following conclusions

"Microscopical examination of the specimen removed from the mediastinum of Phyllis H, shows a tumor composed of rather large round cells of uniform size with a vesicular cytoplasm A large number of thin-walled blood-vessels are present throughout the tumor tissue and the round cells appear to have a close relationship to the walls of these vessels For this reason one is justified in making a diagnosis of angiosarcoma rather than lymphosarcoma which ordinarily would be made in a tumor presenting this type of cells The derivation of the tumor cannot be determined from the material submitted"

The wound healed nicely and it was advised that treatment with Coley's mixed toxins should be instituted This was carried out by Doctor Pollak beginning April 25 with one twenty-fifth of a minim This was followed by severe reaction For eleven days the injections were continued in increasing doses up to $4\frac{1}{2}$ minims After this the treatment was refused by the mother on account of the severity of the reaction phenomena

May 6, 1924, only three weeks after the operation, the child began to walk the relief apparently having been due to decompression However the improvement continued and a series of X-ray pictures by Dr H B Phillips showed gradual disappearance of the tumor mass until at the last observation October 13 1926 an X-ray picture by Doctor Jacobs revealed what



FIG 1—Röntgenogram showing condition on March 20 1923
Before operation

he considered a normal chest. The child has remained apparently well (See Figs 1 to 3.)

In order to get a possible sidelight on the histological picture, Dr Louis Gross, Director of the Laboratory of Mt Sinai, was consulted, who gave an opinion which coincided with that of Doctor Mandlebaum, except that his terminology was "hemangio-endothelioma."

Dr James Ewing was good enough to examine the same slide and dictated the following: "Malignant cellular tumor of embryonal type composed of many blood sinuses lined by two or more rows of tumor cells.

Very delicate stroma."

It was his opinion that we were dealing with an extremely malignant form of tumor.

The child is presented, walking and with nothing to show for her experience with malignancy except the resulting scar in her back. It is now almost three years since the operation.

Comment—It will be noted that this child received no treatment of her malignant condition except the administration of the toxins and although the injections were few in number, yet the reactions were excessive. This is not the first time that the reporter

FIG 2 —Large right shadow still present though smaller 17 months after Fig 1. Tumor of left side practically gone.

had noted a continuance of the recession in cases of malignancy after this treatment had been discontinued.

DOCTOR LILIENTHAL added that while he presented this case as an isolated one, yet his experience with this form of therapy in a number of other instances had been so favorable that he would strongly recommend its use in inoperable sarcoma and also as a prophylactic post-operative treatment after the surgical removal of operable tumors as well. With the latter object in view, it is not necessary to give doses large enough to produce more than moderate reactions. It should also be noted that in nearly all cases of inoperable malignant growths there are metastases whether demonstrable or not and any treatment which is directed merely to the site of the primary or principal growth should not be expected to affect the distant secondary tumors even though they be of microscopic size.

The action of the toxins is one which affects the entire organism. If there is any selective property in this form of therapy it is manifestly to be preferred to measures which are efficient only at the site of application. In this respect the toxins may be compared to the colloidal lead treatment of

neoplasms which is being tested at present and with encouraging success by its sponsor, Blain Bell, of Liverpool. In the lead treatment however there are at least two disadvantages—first that of lethal plumbism, and second the danger of the perforation of hollow viscera which may be the seat of neoplastic disease. When properly administered, Coley's toxins are not directly dangerous to life. There are, of course reactions, often very severe, but these can be controlled by proper dosage and when all febrile signs have disappeared, which they usually do in a few hours, there is no further danger from the individual dose. Coley has reported numerous cures which have been effected by the toxins and the reporter himself had been fortunate in observing a number of instances in which there has been apparently permanent disappearance of the disease. Some of these will be reported in a forthcoming book which is being prepared by Doctor Coley.

Coley believes that about 10 per cent of successes may be expected. It was the speaker's impression that this estimate is not exaggerated. At any rate he was convinced that there is nothing which holds out similar hope in the treatment of inoperable malignancy.

DR WILLIAM B COLEY stated that he had observed seventeen cases of sarcoma of the spine or sacrum, in all of which the disease had reached the inoperable stage at the time of his first observation. In addition two other cases of inoperable sarcoma of the spine had been treated with the toxins by other surgeons under his direction making a total of nineteen cases in all. This series included ten females and nine males. The locality of the tumor was as follows: Two cervical, seven dorsal, seven lumbar and three sacral. A microscopical examination was made in all but two of the cases and the following classification given: Nine giant-cell, four spindle-cell, two mixed-cell and two round-cell. The age of the patients ranged from ten to sixty years. Nine, or 47 per cent of the nineteen cases remained alive and well from three to twenty-four years, one patient died of a recurrence at the end of six years. In the nine cases in which recovery took place the toxins alone were used.



FIG. 3.—The same patient 2 1/2 years after treatment by toxins. Doctor Jaehes reports this chest as normal, not counting of course the slight changes which may be observed in the ribs on the right side.

DOCTOR COLEY gave a brief history of some of the most noteworthy of these cases as follows

CASE I—D G, male, aged twenty years, was always in good health until the latter part of 1901, when he developed a swelling in the mid-dorsal region. This grew rapidly and partial paralysis of the lower extremities developed a short time later. He was sent to the Montefiore Home for Incurables in February, 1902. Examination at this time showed a very large tumor occupying at least five or six of the dorsal vertebræ. The patient had complete paralysis of the bladder, rectum, and lower extremities, and had lost fifty pounds in weight. The condition seemed to be absolutely hopeless. He was put upon the mixed toxins of erysipelas and *Bacillus prodigiosus*, which treatment was kept up for four months. The improvement in his condition was immediate and marked, in a few months he was able to walk about with a plaster jacket. His recovery was complete, and a few years later, he married and now has two children. Physical examination in March, 1924, showed the patient to be in excellent condition and he is still in good health, twenty-four years since the treatment was begun.

Dr Harlow Brooks, Professor of Pathology, Bellevue Hospital, examined a section of the tumor microscopically, and pronounced it a round-cell sarcoma. Numerous atypical giant-cells were present, but whether or not the tumor would ever metastasize, it was impossible to say. At any rate, there was no question but that it was highly malignant locally, and of very rapid growth, and, undoubtedly, would have killed the patient in a few months had it not been controlled by treatment.

CASE II—Baby W, male, aged two years and nine months, was first seen in March, 1911. In February, 1911, the father, while holding the child in his arms, was thrown out of a wagon. Nothing was noticed at the time, but the spine of the child was undoubtedly injured. One month later he began to get weak, and in the latter part of March a swelling was noticed about two inches above the upper border of the clavicle on the right side. This increased rapidly in size, and the patient continued to lose power of his muscles. The condition was regarded as infantile paralysis. There was marked muscular tremor of both hands, and almost entire loss of power in the arms, the patient could not move himself at all, neither was it possible for him to hold up his head. An exploratory operation was done by Dr Stuart McGuire, of Richmond, Virginia, which revealed the presence of a well-defined tumor springing from the laminae and transverse processes of the cervical vertebræ. A section was examined microscopically, and pronounced fibro-sarcoma.

The toxin treatment was begun in July, 1911, and kept up for one year. The child's weight steadily increased during the course of treatment, he regained considerable power so that he was able to move his hands and legs, and could hold up his head. Doctor Ewing examined a section of the tumor microscopically in March, 1922, and stated that while he was unable to offer a positive and exact diagnosis, he was certain that it was a malignant tumor which might well be called sarcoma. He was inclined to regard it either as an endothelioma secondary to the cerebral growth or possibly a neurocytoma derived from misplaced nerve tissue in the cranium.

In May, 1921, Dr Harvey Cushing performed a laminectomy, and found what he considered a very extraordinary tumor plastered all along the spine, though entirely extra-dural. While Doctor Wolbach, pathologist, at first called it a ganglio-neuroma, on further examination he pronounced it a neuroblastoma of an undifferentiated type.

There can be little doubt that the tumor found by Doctor Cushing was an entirely different type from the original tumor which clinically and microscopically was unquestionably a highly malignant tumor. That this extensive inoperable tumor completely disappeared under no other treatment than the mixed toxins, and the patient remained well for more than fifteen years, is, certainly, a gratifying result.

CASE III—H B H, male, aged thirty-eight years. In February, 1895, the patient began to lose flesh and strength. Shortly afterward he felt pain in the lower part of the spine over the sacrum and extending down the legs. It was more marked on the right side. On May 2, 1895, he was admitted to St. Luke's Hospital, where he was examined by Dr. F. P. Kinnicut and the other members of the staff. In the opinion of all, the patient was suffering from an inoperable sarcoma of the sacrum and pelvis. He had lost forty-one pounds in weight and could walk only with the greatest difficulty.

May 10, 1895, a brief trial of toxin treatment was begun. The injections were made directly into the buttocks. At the end of one week, the pain had almost entirely subsided, and the lameness was much improved. At the end of seven weeks, the patient had gained twenty-eight pounds in weight and appeared in excellent condition. He remained well and free from recurrence for seventeen years, when in an accident, he received an injury to his skull which resulted in his death.

CASE IV—The following case of recovery from an inoperable osteosarcoma of the vertebrae was reported by Doctors Miketta and Oliver, of Cincinnati, in the *Lancet Clinic*, May, 1910. The history in brief was as follows. A young girl, aged sixteen years, first noticed pain in the upper cervical region in 1907. A small lump appeared in the region of the posterior cervical glands in 1908, and in 1909 the symptoms became more pronounced. In August, 1909, she developed paralysis, there were paralytic symptoms from the neck downward. Rontgen-ray examination by Doctor Oliver showed an osteosarcoma of the second cervical vertebrae, which diagnosis was confirmed by neurological examination.

The toxin treatment was begun in October, 1909, and continued until February, 1910, a total of 52 injections being given. Marked reactions and severe chills (sometimes lasting forty-five minutes) followed the injections. The temperature, however, rarely rose above 99 to 101°, and only on one occasion did it reach 103° F. An injection was given every other day, but after a severe reaction was produced, one only every third day was given. Only slight improvement in the condition was noticed at first, but at the end of two months, the improvement was more rapid. Motion and power returned in the head and arm first, and then in the lower extremities. In April, 1910, the patient was able to perform every movement. She made a complete recovery and was still well when last traced, seventeen years later.

CASE V—Another case is that of a giant-cell sarcoma of the sacrum involving the coccyx. In May, 1912, an operation was performed at the Mayo Clinic consisting of removal of two lower segments of sacrum as well as the coccyx. Administration of the toxins was begun immediately after operation. The treatment was kept up for about two months in doses sufficiently large to produce severe reactions. The patient was well when last traced, eleven years later.

CASE VI—In August, 1918, Doctor Coley, in consultation, saw a female adult at Mt. Sinai Hospital in which a diagnosis of sarcoma of the lower dorsal spine had been made. Rontgen-ray examination showed a tumor of the middorsal vertebrae, and there was paraplegia of the lower extremities.

The toxin treatment had already been started, and, on Doctor Coley's advice it was continued. Marked and steady improvement in the condition was noted, until the patient had completely recovered the use of her limbs. When last traced, two and one-half years later, she was in excellent health and able to do her own house work.

CASE VII—Dr. Torr Wagner Haimel, of Boston (*The Boston Medical and Surgical Journal*, March, 1915), in a series of cases of inoperable sarcoma treated with the toxins, reported the following: A boy, aged sixteen years, had fallen striking on his spine.



FIG. 4.—Photomicrograph (by Roy M. Allen, magnification 75 \times) of section of tumor from the Pathological Laboratory of Mt. Sinai Hospital. See report of Pathologist.

Pain and tenderness persisted in this region, followed by numbness over the external and anterior surface of the right thigh, with absolute loss of sensation. The patient was admitted to the Massachusetts General Hospital three months later, at which time he walked with slight instability, complaining of weakness of right knee, and intense pain in lower dorsal region of spine. He was operated upon by Doctor Porter, who removed the transverse process, curetted the bone, and trimmed the capsule as much as possible. Doctor Hartwell examined it microscopically and pronounced it a "richly cellular tumor composed of spindle cells with numerous giant cells. The cells are very atypical and their richness varies in different areas of the tumor, some places being quite fibrous. There are scattered necrotic areas in the tumor tissue." Treatment with the mixed toxins was started at once and continued for seven months.

Injectations were given every other day and then twice a week until a total of 62 had been given, the maximum dose was 18 minims. During the early course of treatment, the injections were made systematically into the belly, legs, and arms, and later into the recurrence which rapidly developed and grew until it measured 5½ inches in length, 3½ inches in breadth and 2 inches in elevation. There was paresis of the right leg. The treatment was kept up in spite of the violent reactions which occurred. The tumor began to slough in several areas and in January, 1913, there was no evidence of any mass nor any disturbance of sensation of limbs. The patient was in excellent health when last traced ten years later.

DOCTOR COLEY believed the result obtained in Doctor Lilienthal's case showed the importance of not abandoning all hope even in the seemingly quite desperate cases. While, he states, it is too early to pronounce this patient definitely cured, the fact that she has remained in excellent health for more than three years furnishes good ground for believing that the result will be a permanent one. Cases treated with the mixed toxins differ from those treated by radiation or even surgery, in that, in the former group once the tumor has entirely disappeared a recurrence seldom takes place and the patient usually remains permanently well. In proof of this he cited the

MEDIASTINAL SARCOMA

results found in a recent follow-up of 93 cases of inoperable sarcoma treated with the toxins alone, reported by him before the Johns Hopkins Medical Society in 1896, as follows: 16 patients have remained alive and well from eight to thirty-three years later, and twelve from ten to thirty-three years. Doctor Coley stated that when we consider how very few cases of malignant tumor, either sarcoma or carcinoma, there are on record in which the patients have been found to be alive and well ten years after treatment, the results obtained in the series just quoted become extremely important. Doctor Coley called attention to the report of Doctor Gibson in the *ANNALS OF SURGERY* for August, 1926, covering 437 cases of all types of malignant disease operated upon at the New York Hospital, in which only 64 patients were found to be living and without recurrence and only 13 had reached the five-year limit.

DOCTOR COLBY stated that Doctor Lilienthal was not only one of the first to be convinced of the value of the toxins in inoperable tumors, but that he was among the first to recognize their value as a prophylactic after operation, and that he had



FIG. 5 —Same specimen. Magnification 350 \times .

employed this method as a routine measure for twenty years or more. The method, according to Doctor Coley, is based on a clinical observation of a considerable number of cases of all varieties of malignant tumors which have disappeared or shown improvement during an attack of intercurrent erysipelas or as a result of inoculation of living cultures of the streptococcus of erysipelas. In a paper published in the *American Journal of the Medical Sciences* in May, 1893, Doctor Coley collected from literature, 38 cases of malignant disease, in 23 of which an attack of erysipelas had occurred accidentally, and in 15 of which it was the result of inoculation. This series included 17 cases of carcinoma, 17 cases of sarcoma, and 4 cases of either sarcoma or carcinoma. In the group of carcinoma, 3 were permanently cured, 1 was well five years later, and in 10 cases decided improvement was noted. In the group of sarcoma, 7 patients were alive and free from recurrence from one to seven years after the attack of erysipelas. Eschweiller, in a monograph published some years later, made a very complete study of accidental erysipelas associated with malignant tumors, collecting 69 cases from literature. This series included 27 sarcoma, 38 carcinoma, and 4 cases in which the type of disease was undetermined. Of the sarcoma, there were 9 apparent cures, and 4 cases in which the patient had remained well from two to eight years; of the carcinoma, there was complete disappearance of the tumor in 6 cases, in three of which there was a later recur-

rence In six cases the patient died of the attack of erysipelas Since the publication of that paper, Doctor Coley has collected quite a number of additional cases

Doctor Coley stated that in the last ten years, so much attention had been given to radium and Rontgen-ray treatment of malignant tumors that the value of the method of treatment with the mixed toxins of erysipelas and bacillus prodigiosus had been lost sight of, or relegated to the background He stated that if treatment by radiation could produce better results than those obtained by the older method then there was no occasion whatever for reviving the latter He wished to call attention to the fact, however, that a careful comparative study of the end results obtained by the use of the various methods showed that neither radium nor Rontgen-ray had been able to effect anything like the number of actual cures in inoperable sarcoma that have been obtained by the use of the toxins

DR ALFRED W POLLAK said that in the case of the child who had been presented the intensity of the reactions following the use of Coley's fluid was very great But from the very first injection the healing of the operation wound was extraordinary, and after the third injection the progress of healing of the wound was even ten-fold quicker than before, and after the adverse reaction was over the child seemed to be better generally The hæmoglobin count was 42 per cent at the time of operation and after the eleventh injection it went down to almost 30 per cent Because of the violent reactions the mother requested that the injections be stopped, at least temporarily and Doctor Lilienthal thought this might be done without ill effects and a transfusion be given While the giving of a transfusion was being considered, the improvement in the patient became so marked that matters were allowed to stand as they were and in a comparatively short time the child was up and around Last summer, after the tumor had disappeared, very severe whooping-cough developed, there being as many as fourteen violent paroxysms in one afternoon During the course of this whooping-cough a rontgenogram was taken of the lungs to see if they were affected, but the picture was negative A severe attack of measles and then of bronchitis followed the whooping-cough, but cleared up without any ill effects

DOCTOR LILIENTHAL, in closing the discussion, affirmed what Doctor Coley said, in that he is a consistent user of the toxin, but not all of his patients had survived Nevertheless he considered that Doctor Coley's claims were not exaggerated, for he had had many patients cured who had remained well for a long period of time Doctor Lilienthal had only one thing more to say and that was a suggestion Doctor Coley had spoken of the scientific basis for the treatment It was really empirical in the beginning, founded on the supposed action of erysipelas on sarcoma, which has been known for many, many years Sir James Paget brought that out at least fifty years ago (Clinical Lectures and Essays) Much of the good work

TUBERCULOSIS OF THE BREAST

done in medicine has started as empirical, been sustained by theory and then by anatomy and stood at last on a firm scientific basis. It seemed to the speaker that in this toxin treatment one might find a scientific basis. According to the theory advanced by Gye, it probably takes more than a germ to produce malignancy, so it takes more than a germ to destroy it, Gye believes that it takes a certain chemical substance in the blood together with the germ to produce malignancy. This gives us a suggestion as to why foreign proteins act in producing a cure, they probably produce some change in the physiological chemistry in the body which destroys the medium for the germ of malignancy.

TUBERCULOSIS OF THE BREAST

DR BURTON J LEE presented a woman, forty-five years of age, who was admitted to the Memorial Hospital, May 9, 1924. Four months prior to admission, she first noticed a small lump just above the nipple of the left breast. The mass had seemed to remain stationary in size.

When admitted examination of the left breast revealed, beneath the areola, a small mass about one centimetre in diameter, which felt cystic. The skin overlying this mass was slightly reddened, the mass itself was somewhat fixed to the overlying skin and through one small sinus opening, a slight amount of yellow serous discharge was exuding.

Surrounding this mass, the breast, itself, seemed slightly indurated for a distance of about two centimetres. The nipple was not retracted and there was no discharge from the nipple. Axillary lymph-nodes were palpated in both axillæ, there being two nodes palpable on each side. These were moderately soft in consistence and not tender. Examination of the right breast showed a slight degree of indefinite nodulation throughout the breast.

Rontgenographic examination of the chest made by Doctor Herendeen showed some shadows at the apices, suggesting old, healed tuberculosis lesions.

May 10, 1924, the mass was excised through normal breast tissue, going well wide of the involved area on all sides.

Pathological report of the material was made by Dr. James Ewing and is as follows:

"Specimen is a mass of breast tissue 5 x 8 cm. It consists of solid opaque, finely lobulate opaque reddish-yellow tissue without cicatricial char-



FIG. 1.—Tuberculosis of breast (Chest plate)

acter At one point there are several firm nodules which are ducts distended with inspissated yellow material No definite sign of carcinoma The ducts are widely dilated and filled with inspissated exudate fatty material and structures quite typical of milary tubercles No signs of carcinoma "

There has been no untoward development since that time, the patient's general health has remained excellent, the breast has remained soft without any evidence of disease and the patient has gained 15 or 20 pounds in weight

The case was presented, not because of the comparative infrequency of tuberculosis of the breast, but to call the attention to the possibility of treating some of the cases with limited invasion of the breast, by local excision, rather than mastectomy

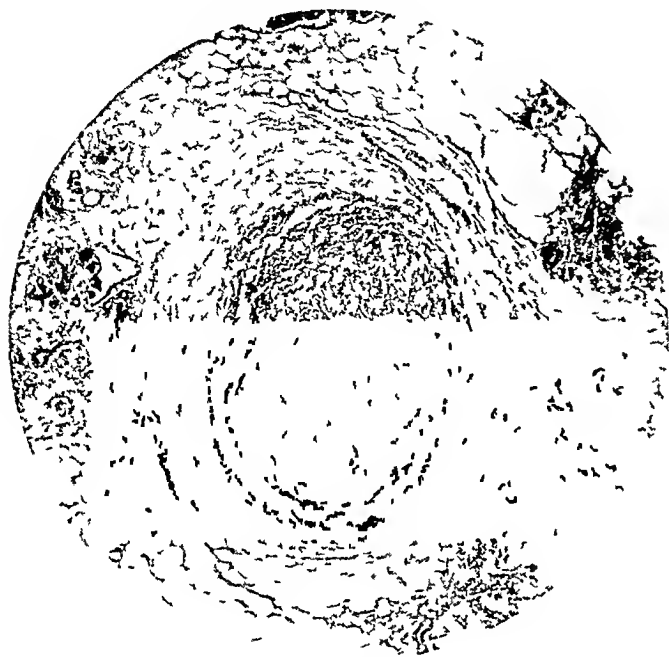


FIG 2 —Tuberculosis of breast (Low power)

tion without removal of the entire breast The patient made a good recovery and is still in good condition twenty years later In this case there was no involvement of the lungs

DR WALTON MARTIN said that he had always considered it wiser, in these cases, to remove the whole breast because one surely in that way goes wide of the diseased tissue In this case, however, the focus was small and Doctor Lee's procedure has proven to be very satisfactory

DR JOHN A McCREERY said that he considered Doctor Lee was fortunate in finding the lesion to be so circumscribed In the few cases he had himself seen the disease was so widely disseminated that removal of the entire breast was necessary

RECURRENT NEUROGENIC SARCOMA OF THE BREAST

DR BURTON J LEE presented a woman, sixty years of age, who entered the Memorial Hospital, November 10, 1926 Six years before she had first noticed a small mass in the left breast Five years ago an amputation of the left breast was performed at St Catherine's Hospital in Brooklyn, and she

RECURRENT NEUROGENIC SARCOMA OF THE BREAST

had remained in good health since then, with no evidence of disease, until about six months ago, when she first noticed a small lump beneath the operative scar. This mass had greatly increased in size up to the time of admission. There had been no pain at any time and no cough. The patient thought that she had lost a slight amount of weight in the few months prior to admission.

Physical examination at the time of admission showed a woman of middle age, rather short and stoutly built, who seemed in good general health. There was a vertical scar over the left anterior chest region about twelve centimetres long. Underlying the lower half of this scar was a prominent tumor, 8 x 8 x 10 centimetres, projecting forward. This mass showed considerable fixation to the overlying skin and was of a hard consistence, with indefinite nodulation over its surface. The mass, were no nodes palpable in either axilla, and although there was slight fulness in the left supraclavicular region, no nodes could be palpated here.

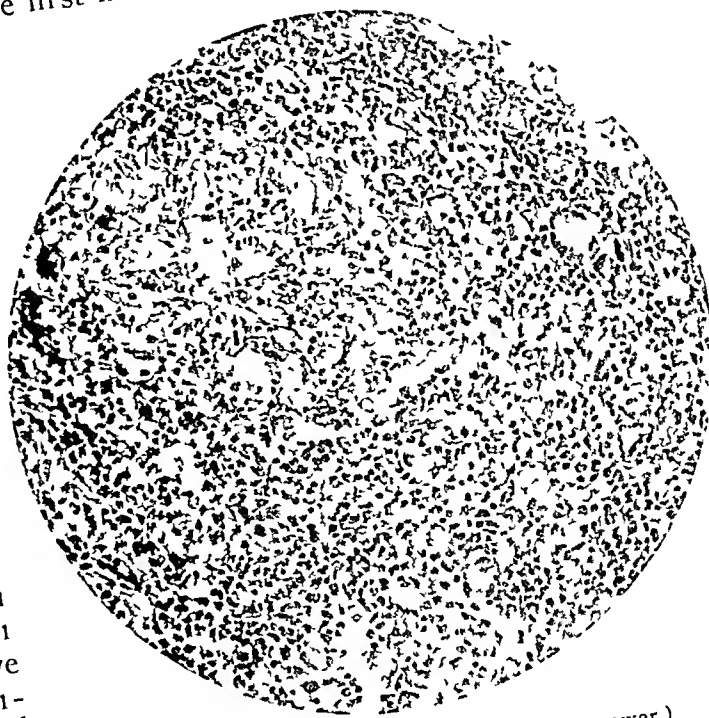


FIG 3—Tuberculosis of breast (High power)



FIG 4—Recurrent neurosarcoma of the breast before operation Photograph

Rontgenographic examination of the chest, made by Doctor Herendeen, was reported as follows:

"There are adhesions of the right lung to the diaphragm. The heart and superior mediastinum appear normal. The large left breast throws a dense shadow, obscuring the lower half of the left lung. The diaphragm on this side can be seen however, and appears normal."

No definite evidence of pulmonary metastasis.

Physical examination of the chest revealed no abnormal signs. Two pre-operative low voltage X-ray treatments were given over the region of the tumor and the adjacent portions of the chest wall. The first was given

November 4 1926, and the second November 6, 1926, with the following factors Time, 25 minutes, 4 m a , 10-inch spark gap, 5-mm aluminum filter 15-inch focal distance One treatment was applied anteriorly and the other laterally



FIG 5 —Neurosarcoma of breast (Gross specimen)

November 11 1926, under a general anæsthetic, the tumor was excised by Doctor Tieves through a transverse, elliptical incision, going wide of the tumor and extending well out toward the axilla, removing all structures down to the chest wall

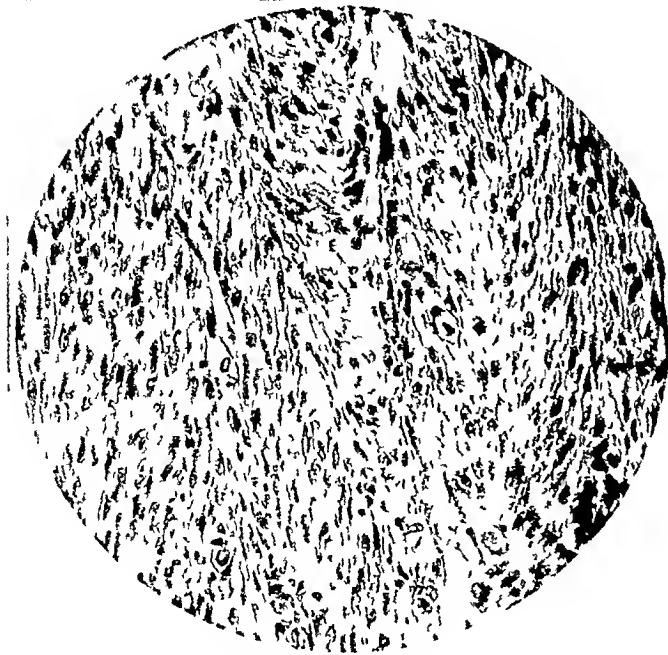


FIG 6 —Neurosarcoma of breast (High power)

Pathological report upon the material was made by Dr James Ewing and was as follows

" The breast is the seat of a single solid circumscribed encapsulated tumor mass 7 cm in diameter It is very firm, opaque on the periphery œdematous softer, with one necrotic spot in centre Tumor has the appearance of a fibrosarcoma Spindle-cell sarcoma fasciculated, somewhat like a neurosarcoma, no epithelial elements "

There was a slight spreading of the wound, due to too early removal of the sutures, but the area of separation healed in rapidly and had prac-

tically closed at the time the case was presented The case was presented for the following reasons

First Because of the great infrequency of this type of neoplasm in the breast

Second Because most of the neurosarcomata operated upon recur quite early

PHLEGMONOUS GASTRITIS

Third Because it seemed desirable to call the attention of the Society to this type of malignant neoplasm, which, in other parts of the body, is sometimes not recognized

PHLEGMONOUS GASTRITIS

DR JOHN C A GERSIER read a paper with the above title, for which see May ANNALS OF SURGERY, vol lxxxv

DR H H M LYLE said that twenty years ago when working on the etiology of linitis plastica he tried to trace the autopsy records of some cases in which phlegmonous gastritis had been given as a possible cause of linitis plastica so he could appreciate the amount of hard work Doctor Gerster had put on this paper

As to the suggestion made by Doctor Gerster that some of the an-acid stomach cases which die after operation may have a localized form of this lesion starting from the gastric operative wound, Doctor Lyle had in mind one such case, and he believes that if routine autopsies were done on all cases one might find it a more common lesion than had been thought

Undoubtedly more cases of acute phlegmonous gastritis occurred after inhalation or ingestion of the irritating war gases than are recorded Doctor Lyle had personally seen cases where the gastric mucous membrane had been so destroyed One of the reasons why more cases were not reported was that only a small portion of the gas cases were autopsied and a still smaller portion had a complete autopsy Very often the autopsy was quickly done in order to find out what kind of a gas was used and not infrequently only the lungs, heart and liver were examined It is known that many of the vesicant gases caused marked infiltration and hemorrhages into the submucosa with a resulting destruction of the overlying mucous membrane

DR KIRBY DWIGHT reported a case of phlegmonous gastritis on the Medical Service of Doctor Floyde at Roosevelt Hospital The patient was a man, fifty-four years of age, who came to the hospital last July with dysphagia as the principal symptom A diagnosis of carcinoma of the oesophagus was made and verified by X-ray and oesophagoscopy He was in fair condition Physical examination showed very little, a small lymph-node in the left supraclavicular fossa and a mass in the abdomen above the umbilicus and below the liver, the liver projecting below the costal margin were the only abnormalities Temperature was normal White blood-cells numbered 11,000, polymorphonuclears 66 per cent Free HCl 0, total acidity 9 He improved under a well-balanced diet and was discharged after three weeks' stay in the hospital and remained well for four months In November he developed an acute condition and began to vomit, was alarmed and returned to the hospital He vomited repeatedly after that and had severe epigastric pains, the temperature ran from 101° to 104°, being more often at the latter figure He died on the sixth day after admission On opening the abdomen at autopsy the viscera were examined *in situ* and the hardened pyloric extremity of the stomach was palpable below the free margin of the liver The entire wall of the stomach was indurated and pus came from it on

exploring it with a needle. Microscopic examination showed acute inflammation with milium abscesses.

As to the possibility of linitis plastica following cases of phlegmonous gastritis, this depends on the definition of linitis plastica. In the old days many cases were reported to be linitis plastica which would not be so considered now. In that time there was a distinction made between leather-bottle stomach and linitis plastica, and the latter was considered to be benign and many kinds of benign processes were classified as linitis plastica. It would seem now, if one follows the teaching of present-day pathology, that it could only be an apparent linitis which could follow an acute phlegmonous gastritis.

DOCTOR LILIENTHAL asked Doctor Geister if he thought that certain cases of supposed tumor formation, which were never diagnosed and which were apparently cured by gastro-enterostomy, might be of this type. For instance, in one of his cases there was a large pyloric mass with symptoms of obstruction which he had felt sure was a tumor and in which he did a gastro-enterostomy as the first of a two-stage operation, and when he went in two weeks later to do a resection he found a perfectly normal pylorus. He had always thought this was a case of cellulitis of the stomach, but it might have been what Doctor Geister described as chronic phlegmonous gastritis, an infiltration with or without pus between the musculature and the submucosa.

DR WALTON MARTIN said that Doctor Geister had grouped together all the infections of the stomach wall. It is well known that there are a number of chronic infections such as syphilis and tuberculosis as well as the acute infections. This entire group had been considered together, including linitis plastica. It is a difficult question to take up in that way. The acute, diffuse phlegmon is one variety, the more subacute localized infection is another. These form two distinctly different lesions due to pyogenic microorganisms. It is an interesting question to consider where the organisms come from in the acute diffuse phlegmon. Is the starting point a bacterial embolus or is there a break in the mucous membrane? Doctor Geister has classed together a heterogeneous group of very rare lesions and has brought out a number of most interesting points concerning them.

DOCTOR GERSTER, in closing, said it was common to get a history of previous attacks lasting a week or two, which had occurred several months to a year before the final one. In two of the ten cases of resection which ended fatally, the patient made a good operative recovery, but died within six weeks after the operation. In one case death was due probably to acute perforation, in the other to a fatal hemorrhage from a ruptured varix of the splenic vein.

Regarding the suggestion that linitis plastica is a preliminary stage of phlegmonous gastritis, this was merely offered as a tentative surmise.

A number of the patients suffering from chronic phlegmon were afebrile at the time of operation, and the condition was, therefore, mistaken for

PHLEGMONOUS GASTRITIS

carcinoma until the resected specimens were subjected to pathological examination

The speaker had had experience similar to that of Doctor Lilienthal in performing a gastro-enterostomy for a large movable pyloric tumor causing stenosis with gastric dilatation and grossly resembling carcinoma, which at secondary operation a few weeks later was found to have entirely disappeared, from which it was evident that the tumor must have been of inflammatory character

Regarding post-operative phlegmonous gastritis, when one considered the clinical course and gross pathological findings in fatal cases there appeared to be several instances in which the likelihood of post-operative phlegmonous gastritis might reasonably be assumed, but in the absence of microscopical examination conclusive proof was lacking

DOCTOR GERSHBERG said that Doctor Archibald Malloch had furnished him with the history of still another case as follows

Walter J., fifty-eight years, admitted to Royal Victoria Hospital, Montreal (service of Dr. George A. Armstrong), March 28, 1914, died March 29, 1914

Six days before admission there was sudden onset of epigastric pain, which gradually increased in severity, vomiting, the vomitus being chiefly bile, and chills

Physical examination on admission showed a moribund man, with moderate abdominal distention, epigastrium was somewhat resistant. Temperature ranged between 102° and 107° . Pulse was imperceptible, respiration 36. White blood-cells, 9600

Diagnosis. Acute pancreatitis or perforated ulcer

The patient died nine hours after admission. Autopsy showed no peritonitis, diffuse phlegmonous gastritis from pylorus to cardia, confined to submucosa, no ulcer

Cultures gave streptococci

Microscopical examination showed oedema of mucous membrane. The submucosa was thickened to five or six times normal width, and was crowded with pus cells and streptococci. The muscularis was involved to the peritoneal coat. The duodenal mucous membrane was entirely normal

BRIEF COMMUNICATIONS

RUPTURED GASTRIC ULCER IN INFANCY

As a result of the rarity of ruptured ulcer of the stomach in children little interest has been manifest in the disease. A study begun with the idea of obtaining rather than imparting knowledge upon the subject, revealed that the literature dealt mainly with reported clinical cures of cases which have not undergone perforation, or with autopsy reports of few very young infants in whom either death occurred from perforation or hemorrhage.

NUZUM¹ reports two cases, one in an infant twenty-four hours old who vomited two ounces of blood upon three occasions and the conclusion was drawn that she had a gastric ulcer which had been present before birth. The other case was that of an infant fourteen hours old who died, and the autopsy revealed a perforated ulcer of the duodenum.

BISSET¹ reports a case of death from hemorrhage in an infant forty-five hours old. Autopsy showed an acute gastric ulcer with clear cut perforated margins situated on the posterior wall of the stomach near the cardiac opening.

FINKELSTEIN¹ of Berlin, states that duodenal ulcer is rarely seen in the newborn, and reports only five cases where an ulcer of the duodenum was found in the first few weeks of life.

An infant six months of age who vomited large quantities of coagulated blood and passed tarry stools, was reported by Shannon² as a case of gastric ulcer. The child subsequently died of pneumonia a few months later, but no autopsy was performed.

KOEHLER³ is of the opinion that ulcers of the stomach in children are not very common and describes in detail the history of a school-girl aged eleven years, who eventually was operated upon for multiple peptic ulcers. Her recovery was uneventful and several months after the operation was well and strong.

LOUDON⁴ records an interesting history of a child two months old suffering from duodenal ulcer. The baby died from hemorrhage and a post-mortem examination revealed an acute ulcer on the posterior wall of the first part of the duodenum, while a second small ulcer was situated near the pylorus on the anterior wall of the duodenum.

A number of different theories have been advanced as to the cause of these ulcers. Hunter is of the opinion that infection in childhood may cause it, and Weber also believes that preceding diseases are a predisposing factor. Roseman and Anderson found structures resembling stomach ulcer in guinea pigs that had died of diphtheria. Loudon is inclined to the belief that thrombosis of the umbilical vein may cause thrombi in the vessels of the duodenum which probably lead to ulcer. Weber⁵ supports his views by describing two cases of gastric ulcer which began in the eleventh and ninth years of life, respectively. Both children were operated upon and made uneventful recoveries.

A striking feature of acute ulcer, according to Alden⁶ is the large percentage of perforations. The first evidence of the presence of ulcer may be a sudden hemorrhage or pain from perforation, although the symptoms may be masked by those of an infectious disease. Pain and tenderness was noted by Alden in 13 per cent of the acute cases, and in over 60 per cent of the chronic cases. It was localized in the epigastrium in older children and in

RUPTURED GASTRIC ULCER IN INFANCY

younger children it seemed to be over the entire abdomen. Vomiting usually followed diarrhoea in acute cases in infants. In older children it followed epigastric pain and relieved the diarrhoea. Hæmatemesis was noted in 40 per cent of the cases. Fever was noted in a great number of acute cases at times as high as 106 degrees. Diarrhoea was a prominent symptom and was present in almost half the acute cases.

My personal knowledge of the subject is confined to one case and can be neither very definite or convincing, but the case presents some features which in the light of the operative findings seem worthy of record.

REPORT OF CASE—S. H., a girl, fourteen months of age a patient of Dr. Ralph Bell of Media, Pa., was admitted to the Chester Hospital, June 6, 1926. The child was examined by Dr. Elizabeth Clark, to whom I am indebted for the following history. One week ago the child became restless and feverish. She vomited several times and evidently had abdominal pain. An obstinate constipation had become a marked feature of her condition. She was a full time baby. Normal delivery, breast fed until nine months old. Always healthy until three months ago when she contracted measles and this was followed, two months ago, by an infected finger from which pus freely discharged.

The patient was a well developed baby fourteen months old. Very restless and continually rolling its head. The skin is dry and hot. Not emaciated but some evidence of dehydration is present. Temperature 102, pulse 140, respiration 60. A mass appears below umbilicus, its longest diameter transverse, definitely outlined and tender to palpation. The abdomen is not rigid. In upper abdomen and in flanks intestinal patterns are apparent. A post-operative note which I made was appended to the history. "Could not definitely make out the mass described above. It impresses me more as a rigidity of the recti muscles. The rigidity is not board-like in character and there is no tenderness above the umbilicus. The point of greatest tenderness is just below the umbilicus in the midline."

Operation—The peritoneal cavity was opened by a right rectus incision mostly above the umbilicus. As soon as the parietal peritoneum was incised, turbid yellowish fluid began to exude from all portions of the peritoneal cavity. The intestines were distended and inflamed. There was no invagination present. Appendix not inflamed. The incision was extended upward and the stomach explored. A perforated ulcer, large enough to admit the little finger, was found on the lesser curvature 3 cm. proximal to the pylorus. The edges were inflamed and friable. The perforation was closed by four interrupted sutures and the gastro-hepatic omentum was stitched down over the wound. The pelvis was drained with a rubber tube and the abdominal incision closed in the conventional manner. The child never reacted from the operation and died in about four hours.

Summary—Ulcer of the stomach or duodenum is uncommon in children, but should be considered as a possibility in infants when collapse follows a profuse hemorrhage from the stomach or bowels. A ruptured ulcer should be suspected when severe abdominal pain, tenderness and constipation persist without the localizing symptoms of the ordinary causes of a surgical abdomen in infants. Particularly should we suspect ruptured ulcer if added to these symptoms there is present a history of preceding infection or infectious disease.

REFERENCES

- ¹ Nuzum, T. W. A Gastric and Duodenal Ulcer in the Newborn. Wis. Med. Journal 1916, vol. xvii, p. 15, No. 3.
- ² Shannon, R. M. A Case of Ulcer of the Stomach in an Infant of Six Months Probably Syphilitic. Ohio Med. Journal, 1909, vol. v, p. 216.

- ³ Koehler, G F Multiple Peptic Ulcer in a Child Aged Ten Years Northwest Medicine, Seattle, 1916, vol xv, p 373
- ⁴ Loudon, J A L Duodenal Ulcer in a Child of Two Months The Lancet, March 21, 1925, p 605
- ⁵ Weber, M Cases of Ulcer of the Stomach in Children Archi Furklinische Chirurgie, 1925, vol cxxxviii, pp 731-734
- ⁶ Alden, Harry Gastric Ulcer in Childhood Am Med Journal Med Society, Phila and N Y, 1907, pp 133-135

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TUBERCULOSIS OF THE BREAST

In view of the numerous articles appearing during the past year with tuberculosis of the breast as their subject, it may be worth while to report the following case. It seems to be a definite example of spread of the disease from the axillary lymph-glands to the breast.

A married Chinese woman of thirty-one entered the hospital October 12, 1926, complaining of a swollen and ulcerated right breast. One year previously she had noticed a small pustule in the right axilla. At that time there was some redness and induration of the surrounding tissue. There was no pain. A short time after this a similar nodule appeared somewhat nearer the breast, and two months before admission these nodules had broken down and the contiguous breast tissue had become involved. From that time on the breast became more and more extensively involved, with the formation of a large ulcerated area with much purulent discharge, redness, induration, and pain of the rest of the breast. There were daily fever and loss of appetite and strength. During the greater part of her illness she had been pregnant and on admission was nursing her seven-day-old baby, using the left breast. Except for aching pain in her right arm, and headache, she had no other symptoms, and had never before been sick. She was a fairly sick-looking woman, with the positive findings limited to the right axilla and breast. The left breast was a normal lactating one. The right breast was diffusely enlarged, and there was a large sharply margined ulcer occupying about half of the upper quadrant of the breast. Just medial to this was a similar but smaller one separated from it only by a band of skin. Its base was dirty and granulating and there was a profuse purulent discharge. The surrounding skin was blue-red in color. There were two similar but smaller ulcers situated in the axillary prolongation of the breast. A mass of glands could be felt high in the axilla. There was no evidence of tuberculosis elsewhere in the body.

Laboratory Findings—Hæmoglobin, 70 per cent, red blood-cells, 3,464,000, white blood-cells, 9200, with 93 per cent polymorphonuclears and 7 per cent mononuclears. Urine showed a slight trace of albumin, a trace of sugar and a few pus and epithelial cells. Smear from the ulcer showed no tubercle bacilli.

With a clinical diagnosis of tuberculosis of the breast and axillary glands, operation was done October 23, 1926. The ulcers were carefully cleaned and then treated with pure carbolic acid, and gauze was then sutured over these areas. The breast and the adjacent involved axillary tissue was excised without disturbing the pectoral muscles. In spite of a careful attempt to keep wide of the involved tissue, the process had so undermined the skin that it was encountered in several places. The axilla was found to contain two large groups of glands which were removed. The wound was left open and dressed with gauze soaked in saline solution. Rectal ether anesthesia was used.

The immediate post-operative course was stormy. The wound did not clear up sufficiently for skin graft until December 9. This was done by transferring small deep grafts from the thigh. The grafts did well except at the margins which continued a

ANEURISM OF THE INTERNAL CAROTID ARTERY

low grade infection until her discharge December 28. The axilla was especially sluggish in clearing.

Pathological Report—The specimen consists of a breast and two masses of lymph-glands. The surface of the breast presents a large ulcer measuring 2 inches by 1½ inches with sharply defined margins and a blue-red discoloration of the immediately surrounding skin. Two smaller ulcers are present in the flap of tissue attached to the breast. The base of the ulcer is made up of dirty pale granulation tissue. On section the granulation tissue forming the base of the ulcer is seen to extend down for a depth of 1½ inches. There is some supporting fibrous tissue, but no glandular tissue is seen. The bases of the other ulcers are similar. Several of the glands are caseous. Sections were taken from the base of the main ulcer and one gland. These sections were studied at the Peking Union Medical College Hospital, and the following report made.

Microscopic Examination—The section is composed mainly of homogeneous, pink-staining, necrotic tissue and very poorly preserved granulation tissue showing a large number of giant cells with peripherally arranged nuclei. Within this granulation tissue are pockets completely filled with polymorphonuclear leucocytes and cellular debris. There is extensive infiltration throughout the section with large mononuclear phagocytic cells, lymphocytes and large numbers of polymorphonuclear neutrophilic leucocytes. In two areas the tissue is almost completely composed of lymphocytes which are arranged around vessels containing blood and coagulated fluid, although one suspects that these may be the remains of lymph-glands, no peripheral sinus or other structure remains by which they can be identified. Another section shows, in addition to these changes, a large branching duct lined by several layers of rather poorly preserved columnar epithelium. It contains cellular debris and numerous polymorphonuclear leucocytes, and is surrounded by loose connective tissue, which is densely infiltrated with wandering cells and lymphocytes. In another portion of the section definite small islands of mammary glands can be made out. About these is a dense infiltration of wandering cells, several of them being practically replaced by poorly preserved granulation tissue and large giant cells. Within this granulation tissue a number of well-formed tubercles are seen. *Diagnosis*. Tuberculosis of breast with secondary acute and chronic infection.

It would seem that the history of spread of the disease from the axilla, the finding of definitely caseous axillary lymph-glands, and the tuberculosis of the breast would justify the assumption that this case started in the axillary lymphoid tissue.

RICHARD H. MEADE, JR., M.D.,
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ANEURISM OF THE INTERNAL CAROTID ARTERY¹

Extra-cranial aneurism of the internal carotid artery has been reported one hundred and six times. With early recognition and proper operative procedures, the majority of the patients should recover, but in the past a large number of the patients have died because of failure of recognition, blundering or delayed treatment of the cases. Treatment by operation on the carotid vessels offers the best prospect of relief, and in view of the findings in the one hundred and six reported cases, it should be relied on in caring for practically all of these cases.

Winslow¹ has presented a full analysis of these cases with clear clinical observations and conclusions that should receive wide acceptance.

¹From the service of Dr. V. P. Blair, Washington University, St. Louis, Mo.

BRIEF COMMUNICATIONS

The following report is presented to continue the work of Winslow in calling attention to the condition

Woman, thirty-six Family history and past history generally negative No history of syphilis (Wassermann negative) Married Two children, living and well

P I A swelling appeared under jaw in 1919 without symptoms, but very slowly enlarged

In October and November, 1923, there were two short periods of numbness of the right hand and loss of holding power

In December, 1923, she was suddenly paralyzed over the right side, could not talk for three hours, but did not lose consciousness In bed one day

In June, 1924, upper teeth were pulled

In December, 1924, the tonsils were removed and a cyst of some sort is said to have been removed from the mouth at the same time

In February, 1925, she had another stroke similar to the first one In bed one day again This time her face was partly paralyzed

In April, 1925, the third and last stroke occurred In bed two weeks and has been weak on the right side ever since When admitted to the hospital in June, 1926, she stated that her general condition had been getting better since April, 1926, but the tumor in her neck was enlarging and had been doing so since the tonsillectomy in December, 1924 She had been having pain in the jaw and side of head while eating, some frontal headache, some nose bleed, black spots before eyes, and some impairment of vision of the left eye Chief complaint was difficulty in swallowing and pain

She was a thin, worried looking woman, able to be up and around, no apparent disturbance of gait There was a smooth, rounded swelling below and forward of left angle of jaw about 5 x 4 cm in size, pulsation and bruit present Floor of mouth raised and tongue pushed to right by the swelling Few palpable glands in neck Pupils R > L E O M normal KK hyperactive on right with questionable Babinski General weakness on right Blood-pressure, 100/80

This patient had had on the four previous occasions some cerebral anæmia, probably due to a blockage of the blood-flow through the aneurismal sac It was thought that these impairments of cerebral circulation might have already accomplished the same precaution that fractional ligation or preliminary occlusion of the common carotid would, and immediate occlusion of the common carotid was decided on if it should prove necessary at operation

Operation, June, 1926, by Dr V P Blair Left Kocher incision, with a second one down along sternomastoid Glands large, translucent and friable, specimen removed for diagnosis Left common and external carotid, superior thyroid, lingual and facial arteries ligated Main mass just under ramus exposed and opened and 30-40 cc of thick, dark, old blood escaped Not much further bleeding Cavity and wound packed with iodoform and Balsam of Peru gauze

Uneventful post-operative course with patient up and about soon afterwards and trying to do her housework, but too weak for much of it

December, 1926 Reported some nausea and faintness at times, was about four months pregnant KK, biceps and triceps R > L No clonus Pupils round and equal, react to L and A E O M normal Wound entirely healed Patient appeared cured

REFERENCES

- ¹ Winslow, Nathan Extra-cranial Aneurism of the Internal Carotid Artery Archives of Surgery, vol xiii, p 689, November, 1926

J B BROWN, M D,
St Louis, Mo

BOOK REVIEWS

ATLAS OF THE HISTORY OF MEDICINE—ANATOMY BY DR J G DELINI, Lecturer on History of Medicine at the University of Leiden With foreword by Charles Singer Paul B Hoeber, New York, 1926 Cloth, folio, pages 96

A series of figures illustrating the history of anatomy, a few plates illustrative of the crude anatomical ideas of the Dark Ages up to the time of Leonardo DaVinci and Vesalius illustrate most strikingly the real creation of anatomical illustrations which those two geniuses accomplished

The main interest and value of the book however, is in the portraits of the Masters of Anatomy which constitute the greater part of the book. Of course, Hippocrates, and Aristotle and Galen and Celsus are included and the dissection scene from DeKetham, DeChauliac and Mordino are not omitted but the real interest begins with Guinther of Andernach the Master of Vesalius and of Vesalius himself followed by Fallopius, Ingrassias Colombo, Coiter, Fabricius of Aquapendente, Severinus, Bauhinus, Paauw Valverde, Servetus and Harvey, Riolan and Hoffman and divers other seventeenth century anatomists, every one of which the student recognizes as associated with particular parts of the human anatomy which bear their names, down to Cheselden, the Hunters, the Bells of later date, and finally Huxley, Schwann, Haeckel and Darwin of the last generation

The writer can imagine how much pleasure and interest such a book would have given him when, as a student, he was becoming interested in the problems of human anatomy. It is given to but few to enjoy the possession of the original books which preserve to the world the work of these masters. Such a book as the present one, which may properly be called an index to the work of the Great Masters, fills a valuable place and ought to be attractive to every scholarly medical student or practitioner of the present day. The editor of this volume expresses its aim in these words "A classical picture of an anatomical procedure, a portrait of one of the heroes of anatomy, or the title page of one of the great anatomical treatises of the past can awaken the memory of some anatomical discovery which may become fixed thereby. To aid the study of Anatomy in this way is the chief aim of this atlas. But its author would ask for it also a place in the library of the practitioner who may desire to occupy his leisure with the study of the History of Medicine."

The book certainly fulfills the object aimed at by its compiler

LEWIS S PILCHER

INFECTIONS OF THE HAND BY LIONEL R FIFIELD, F R C S, Surgical Registrar, London Hospital Paul B Hoeber, New York, 1927 Cloth, 12 mo, pages 192

This is a hand-book that one may slip readily into one's overcoat pocket. It has, however, treated its subject in a very complete and satisfactory manner

the more so when are taken into consideration the peculiar difficulties of the subject incident to the intricate anatomy of the region involved, and the frequency and importance of the infections which so often result in irreparable damage to important structures and functions

It is a simpler book than the masterly monograph of Kanavel. Every attempt is evidently made to keep the size of the book within moderate limits and the wonder is that in so condensed a manner, the author has been able so clearly to present the important essentials of the subject. It is not only profusely but also intelligently illustrated. The cuts show dissections, serial cross-sections, injections of synovial and cellular tissue spaces and many radiographs.

Naturally, the subject belongs rather to the domain of minor surgery and will appeal more especially to the advanced student and to the general practitioner. It, at the same time, however, is worthy the occasional attention of the advanced surgeon. We commend the book to the attention of every one who may have to do with a hand infection.

LEWIS S. PILCHER

SOUTH AMERICA, AMPLIFIED TO INCLUDE ALL OF LATIN AMERICA. By FRANKLIN H. MARTIN. Director General American College of Surgeons. Revised edition. 12mo, cloth, 435 pages. Fleming H. Revell Co., N. Y., 1927.

It was the writer's privilege to spend the winter of 1923 in South America. The picturesque scenes of Rio de Janeiro and Buenos Aires gave an excellent introduction to a two weeks' sojourn on the shore of Lake Nahuel Huapi in Patagonia and thence across the Andes by boat and mule back to Chile at the southern end of the Chilean Central Railway, then up the great central valley of Chile to Santiago and thence to Valparaiso and Lima and Tacna and Panama, all of which experiences were the subject of a chapter in our "Surgical Pilgrim's Progress." During the whole journey, however, we carried with us the original hand-book of Doctors Martin and Mayo which had been published only the year before. We found the book a mine of information and a most valuable guide for travel, more particularly so for the medical man, inasmuch as the spirit which had prompted its compilation had been to promote a better acquaintance between the physicians of North and South America.

Now here, four years later, comes a second edition, revised and amplified by additional chapters which include all of the Latin American countries. The surgeons and medical institutions are dealt with extensively. The general status of the medical and surgical profession in that part of the world should be of special interest to us for the frequency with which the professional men of the North American states are being drawn to visit South America and the Isthmus in their vacation trips is increasing and is likely to become more

marked as the years go by From the point of picturesqueness and general interest, the trip equals that to any other part of the world From the point of restfulness, it is ideal

LEWIS S PILCHER

HUMAN PATHOLOGY A Text-book By HOWARD T KARSNER, M D, Professor of Pathology, School of Medicine, Western Reserve University Cleveland, Ohio With an introduction by Simon Flexner, M D Philadelphia and London, J B Lippincott Company 8vo Cloth, pp 980

THE object of this book is to present the morphological alterations incident to disease, in the light of modern views as regards their functional significance In view of the fact that this is a text-book and because in the study of pathology an acquaintance with the names of the pioneers and the outstanding figures in this subject is desirable, a list of such names is found at the end of each chapter The references are so complete that in several instances there are upward of 100 names given, along with the titles of the monographs and the volume, page, date and name of medical journal in which they appeared To discuss the text content is unnecessary in a review of this sort Suffice it to say that every conceivable pathological process to which human flesh may fall heir is fully, completely and intensively discussed, the author keeping in mind constantly its relation to clinical and functional disturbances

The introduction written by Simon Flexner abounds in sincere praise for the author In conclusion Doctor Flexner states that this text-book presents the subject of pathology as now conceived and taught in this country and in Europe in a manner suitable for the medical and biological student as well as for the practitioner of medicine desiring to keep abreast of this ever enlarging subject He states further that the prospective reader is to be congratulated on having available such a text-book as is this

MERRILL N FOOTE

UROLOGY A Text-book By OSWALD SWINNEY LOWSLEY, M D, of the Brady Foundation of the New York Hospital and THOMAS JOSEPH KIRWIN, M D 8vo, cloth pp 699 Lea and Febiger, Philadelphia, Pa, 1926

THIS single volume of 699 pages consists in a complete resume in the form of a text-book of Urology It is based upon eighteen years of practical and intensive study and clinical observation As a background for the work the authors have used the methods of the old masters of the subject picking out the procedures which time has proven to be reliable and efficacious To this background they have added the modern modifications which have brought the work up to date The elimination of the non-essentials has been such that the book contains only procedures of value

The anatomy embryology morphology and anomalies are given due consideration The operative technic is well illustrated by numerous plates and diagrams of which there are 246 Of especial interest is the portion which deals with regional anesthesia

BOOK REVIEWS

The book is divided into three parts. The first part concerns itself with an introduction along with the complete but condensed history of urological surgery beginning with the ancient Hindoo literature and coming up to the present day urologists. The second part deals with diagnostic procedures in urology. The third part in which there are ten chapters deals with the diseases of the genito-urinary organs and their treatment.

The book is so condensed yet complete, the illustrations are so vivid yet not too diagrammatic, its presentation is so detailed and individual yet so straightforward and easily comprehended that it is highly recommended for not only the urological surgeon but also for the use of the general surgeon and practitioner of medicine.

MERRILL N. FOOTE

CHANGE OF EDITORIAL ADDRESS

The office of the Editor of the *Annals of Surgery* has been changed to 489 Washington Avenue, Brooklyn, New York. All contributions for publication, Books for Review, and Exchanges should be sent to this address.

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EXPERIMENTAL RESEARCHES UPON VASOMOTRICITY¹

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THE facts which we have observed during the past few years, thanks to the surgery of the sympathetic system, seem to us incompatible with the classical ideas on the mechanism of vasomotor actions. They are precise facts, graphically registered, which anyone will be able to reproduce if he puts himself under the same conditions as we did. They seem to imply a revision of the actual theories on vasomotricity. One will judge.

FIRST GROUP OF FACTS

I. If one removes, in man, the totality or almost the totality of the cervical sympathetic chain, one observes, at the level of the superior limb, after a very short phasis of increase in the arterial tension, a marked lowering of the pressure (5 cm of Hg), bearing on the maxima and on the minima. Then, after a few weeks, the arterial tension reaches again its preceding value and maintains it, usually a little below the pre-operative rate.

The modifications are bilateral, their evolutions are parallel and simultaneous on both sides. Sometimes they reach the four limbs where one observes everywhere and at the same time the same variations as previously indicated.

Then, after a few weeks, it becomes impossible to put in evidence the least vasomotor sign of a sympathetic neurotomy. There remains not a single trace of vasomotor paralysis. But, on the operated side, the reactions to external conditions do not take place any more (reactions to hot and cold baths by immersion of the hand belonging to the operated side).

Here is an example of it.

A man is submitted to the entire removal of the cervical chain down to the stellate ganglion (exclusively). One adds to this removal the section of all the rami coming from the stellate ganglion (C⁶, C⁷, C⁸, D¹) and of the roots of the vertebral nerve. Before the operation, one had noted

	On the right side	On the left side
Mx	18	19
Mn	9	6
Index	45	4

¹ Translated by Jean Verbrugge-Anvers

and eight months later, one finds

	On the right side	On the left side
M _x	19	19
M _n	10	10
Index	45	45

2 The resection of the stellate ganglion, which means practically the suppression of all the vasomotors of the upper extremity, has the same effects, the modifications are bilateral After a few weeks, there is also a return to the preceding value and stabilization at that level

Here is an example of it

Mrs L is submitted, for asthma, to an extirpation of the right stellate ganglion The day previous to the operation, the blood pressure had been

	On the right side	On the left side
M _x	13	13
M _n	9	9
Index	3	3

21 months later, we find

	On the right side	On the left side
M _x	13½	13½
M _n	9	9
Index	3½	2½

At the same time, the cutaneous temperature measures at the level of the pommels

To the right	36.5°	To the left	36.5°
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and the tonometer of Gartner shows at the level of the middle-finger

On the right	14 cm of Hg	On the left	14 cm of Hg
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3 The results are the same if one cuts all the rami belonging to the superior limb, from C₂ to D₁ inclusively, including or not the branches of origin of the vertebral nerve²

Here is an example of it

A woman undergoes the section of all the rami of the neck from C₂ to D₁ inclusively for angina pectoris One notes before the operation the following values

	On the right side	On the left side
M _x	12	11
M _n	9¾	8
Index	¾	1¾

One year afterwards, day for day, we find

	On the right side	On the left side
M _x	12	12
M _n	7½	7.5
Index	1½	1¾

When the circulatory conditions are thus reestablished, generally speaking, the reactions of adaptation to heat and cold are once more normal Only twice

² Leriche et Fontaine Des modifications de la pression arterielle consecutives aux ramicotomies inferieures Archives des maladies du coeur Janvier, 1926, T. LV, p. 21

were they incomplete, there was question in both cases of patients having undergone, on both sides, a resection of the ramus of the brachial plexus and a humeral sympathectomy, once for a Raynaud's disease and once for sclerodermy. The study of the blood pressure gave, in one of these cases, the following results

Before intervention

At rest	On the right side	On the left side
Mx	14	15
Mn	5	6
Index	3	4

After a cold bath	On the right side	On the left side
Mx	11	11
Mn	6	6
Index	2	2

17 months later

At rest	On the right side	On the left side
Mx	12	13
Mn	7	7
Index	3½	5½
After a cold bath	On the right side	On the left side
Mx	12	12
Mn	7	7
Index	3	5

In the other case, it was almost identical. One conceives, however, very well that, after a particularly extensive neurotomy, one may easily lose the possibility of adaptation of the extremities to the external conditions.

4 Likewise, the cutting of the lumbar chain, between the second and third ganglion for example, the section of all the lumbar rami are followed by an active vasodilatation which lasts from three to four weeks and ceases by and by, allowing the normal conditions to reappear gradually. Here again, the modifications are parallel in their evolution and take place bilaterally.

5 In man, we have not resected the whole lumbar chain, but we have noted that the extirpation of a single ganglion has the same effects as ramisection. In the dog, two months after the unilateral extirpation of the lumbar sympathetic system (ganglions L2, L3 and L4), blood pressure simultaneously registered in both femoral arteries with two manometers of François Frank, is rigorously similar on the operated side and on the healthy one.³ The vaso-motor reactions produced by any of the usual procedure are the same on both sides as far as the sense of the reaction and its value are concerned.

³ One knows, however, that Claude Bernard has noted in a dog, eighteen months after the extirpation of the superior cervical ganglion, a persistent vasodilatation with hyperthermy at the level of the paw. But one may have a persistent hyperthermia in cases where the pressure has come back to the normal.

In one case, we have seen after a year the temperature of the peripheric parts remain 4° below the temperature of the opposite side, while the pressure and the oscillometric index had come back to the normal.

After all, the section of all the ram, said to be vasomotor, of a limb, never produces any durable trouble of vasomotricity and especially never does it bring about any vasomotor deficit

Here are some more facts which will help to testify in the same way

6 The liberation of the median cervical chain, the extirpation of the median cervical ganglion, produce a marked pharyngeal and laryngeal active hyperæmia, strong enough to reach sometimes the stage of an œdematous exudation. It lasts three to four days, then disappears completely without leaving trace ⁴

7 Periarterial sympathectomy brings about all the signs of an active vasodilatation and in a few weeks the vasomotor reactions come back to the usual rate ⁵

8 The resection of an obliterated arterial cord ⁶ provokes a vasodilatation acting in the same sense as in periarterial sympathectomy, with active local hyperæmia and hyperleucocytosis ⁷. Vasodilatation is more persistent than after sympathectomy, but it always tends to come back to normal

9 In certain rather particular cases (Buerger's disease) where one finds obliterated venous cords under the skin, the resection of one of these cords produces a momentaneous active vasodilatation of the same type as the arterial resection

After all, there is no sympathetic operation which would be followed by vasoparalytic phenomena. All those which we have been able to perform on men (and those which we have been able to perform experimentally on animals in a similar way) have been rapidly followed by an active temporary vasodilatation which does not remain localized to the downward territory, but usually extends to the limbs

After more than 300 sympathetic operations at all levels, we do not know yet at which level we should act in order to reach vasodilator nerves. Everything happens as if there were none, although, however, the vasodilator actions are constant. It does not seem that up to now these surprising observations have impressed the physiologists

Another new fact which should be put forward is the bilaterality and even the generalization to the four limbs of vasomotor actions produced by any sympathetic section. This fact alone is sufficient to show the impossibility in which we are to continue admitting the classical theory, which pretends to see in peripheral sympathetic nerves, centrifugal nerves, going from the medulla to the vessels with ganglionar interruptions

⁴ Leriche et Fontaine. Faits chirurgicaux touchant l'innervation sympathique du larynx et du pharynx. La Presse Medicale, Septembre 22, 1926

⁵ Leriche et Heitz. Des effets physiologiques de la sympathectomie peripherique. C. R. de la Soc. Biologie. Fevr. 20, 1917

⁶ Leriche et Heitz. De la reaction vasodilatatrice consecutive a la resection d'un segment arteriel oblitere. C. R. de la Societe de Biologie, Fevrier 3, 1917

⁷ Leriche et Fontaine. De l'influence des operations sympathiques sur la leucocytose. La Presse Medicale, Sept. 4, 1926

SECOND GROUP OF FACTS

The cutting of some sensory nerves produces the same phenomena of vasodilatation as the sympathetic operations ⁸

Refrigeration of mixed nerves has the same hyperæmic effects ⁹

The extirpation of neuromas of cicatrization of mixed nerves acts exactly in the same way ¹⁰

In all these conditions, one has only observed phenomena of active vasodilatation. Never have we seen any paralytic phenomena and never any vasoconstrictor phenomena. Likewise, the section of a mixed nerve, like the sciatic nerve in man, never abolishes the active vasomotricity. It does nothing else but disorder the local vasomotor reactions. Several months after the section, one is able to observe very marked hyperæmic crises with rise in temperature of several degrees above normal.

THIRD GROUP OF FACTS

The section of the medulla which is supposed to produce paralytic vasodilatation, leaves unchanged the normal vasomotor reactions. We have seen, after an extensive destruction of the dorso-lumbar medulla (D8 to D10) all the vasomotor reactions persist at the level of the inferior limbs, at the end of three months. The pressure and the oscillations were subnormal (there was œdema present). An intravenous injection of a quarter of a milligram of adrenaline and an intradermic injection of a weak quantity of an extensive solution of adrenaline were followed by the usual reactions, the same result was obtained with hot and cold baths. A periarterial sympathectomy had been followed with the usual vasoconstrictive and vasodilator reactions, without the least quantitative variations ¹¹

In dog, after section of the medulla, vasomotor reactions are not modified, even if one adds to the myelotomy an extirpation of the lumbar sympathetic chain or a section of the sciatic or both of them. Albert, ¹² in his complete experimentation on vasomotor reflexes has always seen the traumatic vasomotor reflexes persist, even after section of the medulla, sciatic and crural nerves.

These facts seem to us incompatible with the existence of classical centri-

⁸ de Nabias. Des resultats immediats de la neurotomie sympathique simple dans les cas d'ulceres variqueux. XXXcme Congres français de Chirurgie, Octobre 5, 1921, p. 447.

⁹ Laewen. Vereisung des Nervus Ischiadicus und des Nervus saphenu bei angiospastischen Schmerzzustanden der unteren Extremitat. Munch. Med. Woch., 1922, T. LVIX, No. 11, p. 389.

Laewen. Ueber Nervenvereisung bei angiospastischen Schmerzzustand. Zentralblatt für Chirurgie, Septembre 1, 1923, T. 1, No. 35, pp. 1346-1350.

¹⁰ R. Leriche et R. Fontaine. Modifications vasculaires consecutives a l'ablation d'un nevrome du plexus brachial. Reunion neurologique de Strasbourg, Decembre, 1925, in Revue Neurologique, 1926.

¹¹ R. Leriche et R. Fontaine. Sur l'etat de la vasomotricite apres section de la moëlle. Soc. de neurol. de Strasbourg, 1926, vol. VI, p. 14.

¹² Albert. Etude exp. des troubles vaso-moteurs reflexes. Arch. Int. de physiol., Mai 31, 1924, f. 4, T. LVII.

fugal vasomotor nerves, going from the medulla to the periphery, the ones being loaded with vasoconstrictive impulses, the others with vasodilator impressions. Our operations on the ramus and on the lateral chains do not allow us to think that, if such are things, it is due to the fact that vasodilators get exhausted before reaching the periphery, as have said certain physiologists.

How could we explain this apparent disagreement between facts and theory?

One single hypothesis seems possible. One has to refer to the periphery the place of production of vasomotor actions which regulate the local circulations. One admits to-day the existence of vasomotor centres at the level of the arterial walls. One may suppose that, between these intra-arterial centres and the ganglionic and medullary centres, there are only sensory connections, fibres of association, of ortho- and anti-dromic conduction after the manner of Bayliss. The physiologists do well admit an influence of these intramural peripheric centres, but they seem to think that they only enter into activity after suppression of the medullary influence.

The facts which we have observed in man seem to show that they play a predominant role in the normal circulation, that, they alone, secure the motor actions, these actions being regulated by excitations, centrifugal and centripetal, coming from all parts of the body and going through the ramus.¹⁷

One thing lacks to this hypothesis, that is the proof of degeneration after sympathetic neurotomy and this proof is indispensable for the elaboration of a valid theory of vasomotricity. We do not ignore that, up till now, the method of degenerations has led to conclusions absolutely contrary to the one which we had to adopt. Langley seems to have established through studies of degenerations that all the sympathetic cells gave rise to centrifugal fibres and never to centripetal fibres. Gaskell has concluded from his research that the sympathetic system was only made of motor fibres and did not include a proper reflex arch. Bayliss also has insisted on this characteristic of the sympathetic system.

However, the facts which we have reported do not allow to admit this conception. They also must be taken into consideration. And without wanting to propose a general theory on vasomotricity, we think that, from now on, the old theory should be discarded, the facts observed in man being incompatible with it.

¹⁷ R. Leriche. Les indications et les résultats de la section des rameaux communicants dans la chirurgie de la douleur. Grouement Belge d'études neuro-chirurgicales, Novembre 14, 1926.

SUTURE OF WOUNDS OF THE HEART

WITH REPORT OF A RECENT CASE

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ALTHOUGH the suture of wounds of the heart has ceased to be a strictly rare operation, it is sufficiently infrequent to be encountered by the individual surgeon perhaps only once or twice, if at all, in years of experience on an accident service. However, in view of the strict urgency of such operations every surgeon should be practically as well qualified to handle such cases as he would a patient who needed a tracheotomy. In 1920, Tuffier¹ assembled the reports of 305 cases of suture of the heart with a mortality of 49.6 per cent. The following case is reported not only because of recovery, but more especially because of the acquisition of complications in rapid succession, with a recovery from each in a manner almost unbelievable.

A colored man, J. D., taxi driver, aged thirty, was rushed into St. Louis City Hospital No. 2 on the 23d of October, 1926, with a history of having been stabbed in the anterior thorax during an argument one-half hour previous to admission. Following the accident, he had driven his taxi half way to the hospital when he fell over unconscious, wrecking the taxi, but apparently sustained no added injury to himself.

When seen in the examining room, the patient was unconscious, but tossing about so wildly that it was difficult to restrain him on the stretcher. He was covered with a cold sweat, his mucous membranes were pale, and he presented many of the other symptoms of profound shock. There was a small laceration 2 cm. long about 1 cm. to the right of the right sternal border in the fourth interspace. The radial pulse was 120 per minute, weak, and irregular, not only in rate, but more strikingly in volume. Heart sounds were very faint, and the same irregularity was noted. A pulse deficit of five beats per minute was present. There was no increase in the area of the cardiac dullness and neither was there any change in pulmonary percussion or auscultation. The blade of the knife, exhibited as the weapon which produced the wound, was broken about 4 cm. from the point. The broken end of the blade apparently remained in the wound. A hurried fluoroscopy revealed nothing of value except the broken end of the knife blade in a fixed position near the midline. Upon retrospection, the lower portion of the cardio-pericardial shadow seemed possibly a bit widened. During the ten or fifteen minutes consumed in examination, the patient's pulse became alarmingly weaker. He was taken to the operating room immediately with the diagnosis of active bleeding either from internal mammary vessels, intercostal artery, or cardiac injury. Since the symptoms resembled so closely the picture described following rapid increase in pericardial pressure, hemorrhage from the heart seemed most likely.

A three-inch incision was made under local anæsthesia along the right sternal border, just medial to the wound. The fourth and fifth costal cartilages were located, and 1 cm. of each removed at the sternal junction. Retraction of the wound revealed the internal mammary as well as intercostal vessels uninjured. In the mid-portion of the sternum was found the penetrating wound and just beneath the surface of the bone, the broken end of the knife blade could be seen. On account of the danger of renewal of hemorrhage,

the blade was not removed at that moment, but the bone cut away from it with a rongeur to allow exposure, if fresh bleeding started. When the blade was freed from its fixation by the bone, it was thrust out of its bed by the beating heart. This indicated quite clearly that the point of the blade was at least in approximation with the heart wall. Removal of the blade allowed a moderate flow of blood to escape through the laceration in the pericardium. This laceration was rapidly enlarged and a huge amount of fresh and clotted blood escaped. Practically immediately after the release of the pressure within the pericardium, the anæsthetist reported that a strong temporal pulse was palpable and the force

of the cardiac contractions could be seen to increase markedly. The rhythm, likewise, returned to normal. After removing the bloody content of the pericardium by careful sponging, a ragged lacerated wound could be seen in the left ventricular wall about 1 cm to the right of the coronary vessel. The force of the heart muscle against the fixed point of the knife blade had apparently enlarged and deepened the wound with each succeeding heart beat. This ragged wound measured about 1 cm by 2 cm and was bleeding quite freely. Exposure was so adequate that it was not considered necessary to apply a stay suture in the apex. Six or seven interrupted sutures were applied before the wound could be closed and all bleeding suppressed. The suture material used was o, twenty day cat-



FIG 1 —Rontgenogram of chest taken at St. Louis City Hospital No. 2 ten days after operation. Note pulmonary consolidation at right base and huge cardiac shadow. Because of the patient's critical condition, this is a portable film and taken in the antero-posterior direction. There seems to be a definite enlargement of the heart shadow even though the rontgenogram was not taken in the routine postero-anterior direction.

gut, except for two final sutures of silk when the eye of the needle used for the catgut seemed to produce too much trauma. All blood and blood clots were then carefully removed from the pericardium and the pericardial sac closed. This tight closure was undoubtedly a grave error and will be discussed later. The rest of the wound was closed around a rubber drain which was inserted down to the dead space produced by removal of part of the sternum. Unfortunately, the patient thrashed about so wildly that ether anæsthesia became necessary before termination of the operation.

Post-operative Course—The next day the patient's temperature was 105° F, pulse 140, slightly irregular and very weak, and respiration 60 per minute. There were signs of a beginning consolidation in each axillary base. Part of these signs were unquestionably due to a moderate pulmonary œdema. Heavy doses of digitalis and atropine as well as sufficient morphine were given. At the end of the second day, the patient's dressing suddenly became saturated with about 100 cc or 200 cc of serosanguineous fluid. A very definite improvement in his condition, especially cardiac, was noted almost immediately. The pericardial suture line had, no doubt, ruptured and a moderate heart tamponade had therefore, been relieved. A frank consolidation of pneumonia developed on the left side

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and remained for ten days with a slight daily drop in fever. At this time the questionable signs of pneumonia in the right axillary and posterior base became definite and the temperature, pulse and respirations again rose. A moderately profuse bloody sputum was present, but became muco-purulent during the third week and was so foul that a lung abscess was feared. However, no auscultatory signs of lung abscess could ever be made out. After the apparent rupture of the pericardium on the second day, the heart sounds were always of normal intensity and so signs of increase in pericardial tension could be found at any time. A marked leucocytosis was always present, but reached its maximum of 36,000 at the time of development of definite pneumonic signs on the right side during the second week of his convalescence.

The drain was removed on the sixth day and the sinus tract almost healed on the tenth day when a slight purulent discharge manifested itself. This ceased during the fourth week and the sinus closed. Almost simultaneously a slight swelling manifested itself just above the right clavicle and the temperature and leucocytosis rose to a higher level. Within twenty-four hours, this swelling was quite definitely proved to be an abscess and was opened under local anaesthesia. Two or three ounces of pus were obtained and the abscess cavity found to extend down under the clavicle. The tip of the



FIG. 2.—Röntgenogram of chest taken six weeks after operation. Nothing abnormal can be made out. The heart shadow is within normal limits.

finger could not reach the lower wall of the abscess, which was quite certainly an abscess of the anterior mediastinum. Culture yielded a streptococcus. Four or five days later, the temperature dropped to normal. He was discharged at about the end of the sixth week of his convalescence.

He was admitted to Barnes Hospital a few days later for examination. The heart shadow in the roentgenograms was easily within normal limits, and no abnormal lung findings were made out. Electrocardiograms were normal. The sinus over the clavicle had closed by the end of the seventh post-operative week and since that time the patient has remained well.

The first man to suture a wound of the human heart was Cappelen² in 1895. The first patient to survive the operation was operated by Rehn³ the following year.

It seems strange that such a vital factor as danger of compression within the pericardium in traumatic heart surgery should be recognized so long ago as 1761 when Morgagni⁴ called attention to it. It remained for Kuno,⁵ however, in 1917, to demonstrate experimentally that when the pressure within

the pericardium attained the height of the venous pressure, the heart ceased to function

In a recent historical and very enlightening article, Beck,⁶ of Cleveland, has very aptly stressed the importance of considering heart tamponade during the operative procedure and in the post-operative course of the patient. Probably his greatest contribution in that article has been the conclusive demonstration that, "as a precaution against tamponade, an opening in the pericardium 1 or

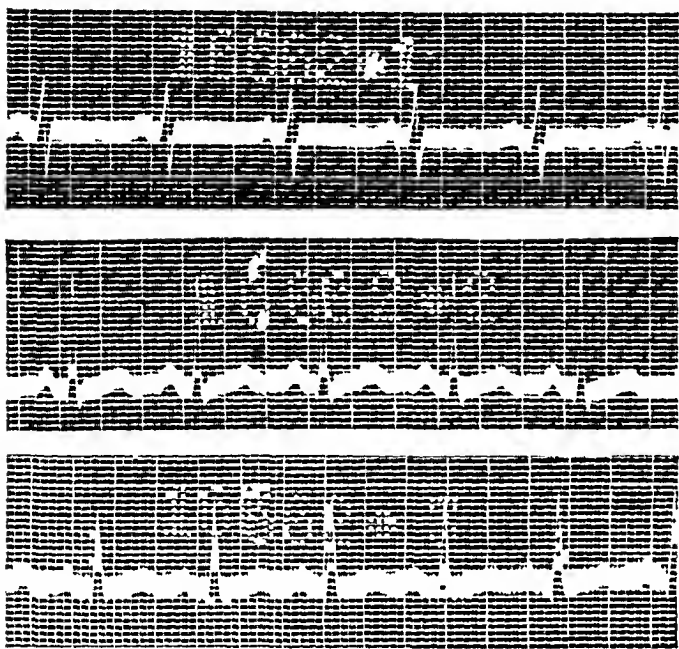


FIG 3—Electrocardiogram six weeks after operation. Report by Dr D Luten. P-R interval 0.16 sec. Rate 98. T waves isoelectric in lead I, upright in leads II and III. Considerable change in amplitude with change in position. Essentially normal electrocardiogram.

2 cm in length should be provided in every operation upon the human heart." He demonstrated further that if the accumulation of fluid within the human pericardial sac exceeded 250 cc within thirty minutes, the heart would cease beating; likewise, that an amount in excess of 150 cc in the pericardial sac of a dog was fatal. These figures obviously apply only to rapid accumulations, since it is a well known clinical observation that if the process of accumulation extends over a longer period of many weeks, as

is seen in the effusions sometimes accompanying pericarditis, Pick's disease, etc., the amount may even exceed a litre in quantity. The acceptable methods of approach and exposure are all identical or similar to the classical operations, that is, median sternotomy, consisting of splitting the sternum, or intercostochondrial thoracotomy, consisting of retraction of the sternum after section of three or four costo-cartilages. The necessity of immediate release of pericardial pressure in traumatic cases seems to favor section of the cartilages and retraction. If exposure is inadequate, subsequent to this approach, a portion of the sternum can quickly be removed. This was done in the author's case, obtaining a perfect exposure of the ventricular portion of the heart. Subsequent observations on the patient have revealed no ill effects from removal of the portion of his sternum. Neither can a pulsation be felt over the area, thus suggesting that the increased susceptibility to trauma is insignificant.

The value of the preliminary application of a stay suture at the apex will depend largely upon the accessibility of the wound. If the wound is difficult of access, thereby requiring possible trauma of the heart muscle or conduction

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system to enable one to expose and repair it, the advantages are evident. However, in the author's case, exposure was so adequate that an apex suture was not deemed necessary. The first repair suture applied was left uncut and served very adequately as a stay suture, thereby aiding materially during the application of the remaining sutures. The value of adequate stay sutures will be very keenly felt if fresh hemorrhage is encountered during the repair, as happened in this case, when a branch of the coronary artery was injured with the needle. The wound immediately filled with a sea of frothy blood, but, with the aid of the stay suture as fixation and a guide, the bleeding was quickly controlled with pressure of the finger, and a ligating suture applied. Manipulation or handling of the heart in excess of that absolutely necessary in the repair is to be avoided. Although animal experimentation and observations on the human heart have shown that heart can be handled with hand, it has also been proved that manipulation which interferes with blood supply of heart muscle whether it be through coronary system or the base of the heart, may be rapidly fatal.



FIG 4—Photograph six weeks after operation. Note scars of healed wound over heart and of incised mediastinal abscess above right clavicle.

The two most important complications following repair of injuries of the heart are infection and reaccumulation of fluid within the pericardial sac. Obviously, if an opening is left in the pericardium at the time of the operation, any fluid which may accumulate will have opportunity for exit. In the series of cases reviewed by Tuffier,¹ about 50 per cent of the fatalities were due to infection. Pericarditis, of course, is most to be feared, and jeopardizes seriously the patient's recovery. Pneumonia, likewise, is a very frequent complication and occurred in the base of each lung of the author's case. This would seem to have an easy and logical explanation, since thrombi would form readily in the injured coronary vessels, and if dislodged, would terminate in the lung.

as emboli, with or without formation of infarcts. The occurrence of infection in the above process, whether it takes place in the heart or later in the lung, is assumed by many authorities to be frequently the precursor of pneumonia. The presence of the bilateral pulmonary oedema, occurring apparently as a sequella of cardiac embarrassment, possibly made the field more fertile for production of the pneumonia.

Surgery of the heart valves and interior of the heart offers a more complicated procedure, and is even more recent in practice than repair of cardiac injury. Vital steps have been taken in its advancement by the introduction of the cardioscope by Allen and Graham,⁷ and the cardiovalvulotome by Beck and Cutler.⁸

BIBLIOGRAPHY

- ¹ Tuffier, T. La Chirurgie du Coeur. V. Congres de la Societe Internationale de Chirurgie, Paris, July 19-23, 1920, pp 4-46
- ² Cappelen, A. Vulnia Cordis, Suture of Hjertet, Norsk Mag f Laegevidensk, 1896, ° vol 21, p 285
- ³ Rehn, L. Ueber Penetrierende Herzwunden und Herznaht. Arch f klin Chir, 1897, vol 14, p 315
- ⁴ Quoted by Beck. Morgagni, J. B. De Sedibus et Causis Morborum. Lipsiae sumptibus Leopoldi Vossii, 1829
- ⁵ Kuno, Yas. The Mechanical Effect of Fluid in the Pericardium on the Function of the Heart. Journ Physiology, September, 1917, vol 11, p 221
- ⁶ Beck, C. S. Wounds of the Heart. The Technic of Suture. Archives of Surgery, August, 1926, vol 211, No 7, pp 205-227
- ⁷ Allen, D. S., and Graham, E. A. Intracardiac Surgery. A New Method. Journ American Medical Association, 1922, vol 121, p 1028
- ⁸ Beck, C. S., and Cutler, E. C. A Cardiovalvulotome. Journ Exper Med, September, 1924, vol 21, p 375

PERICARDIAL DECOMPRESSION IN THE TREATMENT OF WOUNDS OF THE HEART AFTER CARDIORRHAPHY

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THERE can be no surgical procedure freighted with more anxiety than that of dealing with a bleeding heart. Fortunately, enough, injuries of the heart that are amenable to the surgeon's art are of infrequent occurrence. So seldom, indeed, that to prepare one's self for the emergency, should chance or circumstances ever bring it to our door, is so much like preparing for something in which an interest will never be given that an attitude of indifference has been taken by not a few of us. But when we reflect on what a deplorable exhibit this lack of being prepared would make of one, a nerveless bungler instead of a calm and deliberate surgeon who, having in mind, not only the necessity of a rapid and accurate pericardial decompression but the way to go about it as well, there is really nothing that could be said in justification of this attitude.

The motility of the heart is dogged, and yet, despite its doggedness, when bleeding from a wound fills the pericardial sac, there will come a compression within to which that motility must succumb. And when the threatening havoc is being foretold by a deepening cyanosis, an hunger and muffled heart sounds, what a comfort to know how a quick enough pericardial decompression will change the scene from one of due despair to that of certain hopefulness.

"He Who Hesitates is Lost!" I like to associate this hackneyed quotation with the surgeon who may find such a condition confronting him. In their aggregate the five words of this old saying emphasize the expediency of his having to act quickly. Singly they may be likened onto five fingers pointing out the five steps of the operation that is imperative in the presence of such an emergency—namely, (1) a rapid and accurate chondrio-plastic thoracotomy, (2) a rapid and accurate pericardial decompression, (3) a deliberate, though gentle delivery of the heart, (4) suture of the wound—(cardiorrhaphy), (5) cleaning the field and establishing drainage.

My first experience with a bleeding heart was a trying one. Trying because of my deplorable ignorance. I did not know how such an operation was performed for I had never seen the anterior mediastinum opened nor heard its surgery discussed. The best I could do was grope. Grope and bungle until an opening was effected. And then? Blood! Blood that gushed and flooded the field. Hard on this came the hissing of air from a torn pleura, and ere I knew what was the next best move to make, that pool of blood was being churned into a frothy sickening spectacle.

As I view it now the frenzied state into which my mind was forced may well be regarded as a just retribution for my lack of preparedness. And while

it may, in common justice, absolve me from the unsurgical dillydally sponging of the field, there has been less sting to the remorse of it because it was the very act, unsurgical though it was, that became the very means of bringing my finger tips in contact with the tightly distended pericardium. A distention so unyielding that immediately I was made to realize that the blood I had been mopping away was playing no part whatsoever in hurrying the death that was pending. What I was to do next now involved no question. Discarding the sponge in favor of a knife the submerged sac was slit in a longitudinal direction. Out came a gush of blood and clots so great that for the



FIG. 1.—Experimentally produced stab wound that was made to enter the ventricle at right angle to its long axis. Note the almost complete tearing out of the ventricular wall.

moment it seemed enough to be fatal. But it was the very opposite effect that was noted. With the heart's freedom restored the threatening cyanosis began to pale. The change was nothing less than dramatic.

While irrelative to the subject under discussion, I will briefly mention another temper that laid hold on my mind when I had undertaken to lift the heart out of its sac. It struck my fingers with such an apparent direct-

ness that I actually recoiled. It gave me the sensation of having invaded the burrow of some unhappy haunted creature. There was a fear on me when, for the second time, I put my fingers beneath it.

When, on the palmar surface of my fingers, the heart was finally lifted from out the pool, its beating none the less for it, we beheld the wound. It was not a deep one. Only during diastole did it bleed. One mattress stitch and it was securely closed. Iron-dyed silk, popular at the time was the suture material used. The patient made an uneventful recovery. And the lesson that comes from his recovery, while not a surgical one, may be accepted as of equal, if not greater, value in seeing the heart's endurance, against such bungling, enabling it to see it through.

Innate fears can harass us but momentarily when it is duty that brings us to hold within our fingers' grasp the beating heart of a fellow being, nor can it be expected that head and hand remain cool and steady when, without previous training, they are forced to meet so trying an ordeal. The humility that this neglect brought me to bear during the stress of that operation with its blood drenched field—the mockery of the hissing pleura—the churning froth up pool—the horror of it all would have been spared me had I but

known in advance that a bloody field awaited me. Had I but known that nothing, not even the bloodiest of fields, was to delay the vital step of the whole procedure and that that step was the pericardial decompression. And further, to have known that torsion must not be the means of bringing posterior heart wounds into view but instead to carry the apex forward toward where it would describe a vertical line with the base.

With the bleeding controlled, the field made clean, the heart dropped in place and then? To have it in mind *not to suture the slit in the pericardium*.

Why? Because effusion is inevitable to such an ordeal. An effusion that will be copious enough to reenact the same pericardial compression unless given ample room for escape. Nor should the sac be subjected to the irritation of carrying any form of drainage material within it lest the effusion be increased by that seeming intelligence of serous membranes in their effort to wash away a foreign substance.

Merely drain the anterior mediastinum for its floor is the pericardial sac and that has been left widely open. Of material, strips of rubber tissue, loosely rolled, are ideal.

Surgery of the heart will never be free from these besetting dangers that, at any unexpected moment, may thwart the skill of the best. It is in this wherein lies the risk of defeat. And while we know this, to flinch is to acknowledge that lack of courage kept away the realization that failing to act loses all.

There are many surgeons with that omnipotent ability that flows only from years of the richest experience to whom an opportunity of dealing with an injured heart will never be granted. And again, the novice may be given it before he is sure of himself in any field. There is a lesson in this. A lesson no one can well afford to neglect.

Wounds of the heart may be roughly divided into two classes. Those that are immediately fatal and those that are not. The appearance of imminent death must never deter the hand, for there are enough of such cases on record to prove conclusively that a pericardial decompression under similar discouragements has, often enough, changed the scene from one of imminent death to one of assuring hopefulness.

The character of these heart wounds is but seldom ascertained. Nor



FIG. 2.—Experimentally produced stab wound that was made to enter the ventricle at an oblique angle to its long axis. The same knife that was used in the stab wound of Fig. 1.

would it be serving the best interest of the patient were one to undertake the necessary investigation. It is, however, enough for us to know that they occur in degrees from slight abrasions to through-and-through punctures. A puncture that enters the ventricle at a right angle with its long axis produces an almost instant death because the transit blood enters the wound as a dilator and tears out so great a portion of the ventricular wall that the moving blood within the entire system is brought to a sudden stop. Not so with a puncture entering the ventricle at an oblique angle with its long axis. Here,

the tract of the wound is caught between two opposing compressions.

The intraventricular pressure—the muscular contraction. That explains why these wounds close so tight at every systole. It also explains why they bleed only during diastole. That bleeding from oblique punctures during diastole into the ventricle can do no harm is too obvious for comment here. But that which oozes, trickles or actually spouts into the



FIG. 3.—Method of placing mattress suture to close puncture or stab wounds of the heart. We believe the soft floss silk, with its tendency to flatten, the ideal suture material for these particular lesions.

pericardium must, if continued over a sufficient period of time, accumulate until the presence of the death-dealing pericardial compression becomes manifest. (See Figs. 1, 2 and 3.)

When placing the sutures the needle is made to pierce the muscle as deeply as may be possible without getting in too near the endocardium. It is also best to time the needle's thrust with each diastole, otherwise, cutting of the contracting fibres may obtain from over the needle's point. This rule holds good when the sutures are being tied.

When pericarditis with effusion, serous or purulent, is in need of drainage, it cannot be ignored that aspiration includes the hazard of wounding the heart. But should it be agreed that with a certain degree of skill one can thrust the pericardium with a needle without injury to its content, there will still be the disadvantage of having to rest content with having but a partial amount of the fluid withdrawn. Moreover, considering the readiness with which effusions recur we are immediately convinced that the procedure is destitute of the power to bestow a means lasting enough through which recovery could be effected.

Free open drainage by a chondro-plastic flap of the fifth costal cartilage

not only empties the sac completely, but, with the sac left wide open, the recurring effusion has an egress that will endure until the storm passes

When pericardial compression is the result of accumulated blood from a wound, the flap is then made to include the cartilage of the third, fourth and fifth, perhaps the sixth, ribs

It is not always an easy matter to diagnose those wounds of the heart that are going to require the surgeon's skill. There are too many differentiations for that, and besides, there are many conflicting and confusing points of distinction. However, and as a working guidance, we can do no better than to keep well in mind the advice of Rudolph Matas, when he says "Visible external hemorrhage, hidden or concealed hemorrhage, and above all—*signs of heart compression*—call for immediate exploratory thoracotomy"

REPORT OF CASES

CASE I—A high speed emery wheel exploding hurled a number of its fragments throughout the grinding room of The Oil Well Supply Company's plant at Oil City, Pennsylvania. One of the workers was killed almost instantly. Another sustained a small puncture wound of the left chest between the sixth and seventh ribs just beneath the nipple. At the time I was on the surgical staff of the Oil City Hospital, where, within the hour following the accident, I saw him. There had been but slight bleeding from the wound. The pulse was, all considered, of good quality. His face bore a somewhat anxious expression, this we attributed to the pain he was complaining of and which I interpreted as a traumatic pleurodynia. For relief a hypodermic of morphine was given. Nothing present in his condition to make us in the least, apprehensive. But within the next two hours all this was changed. He grew fearfully restless. Cyanosis began to appear. The breathing quickened and became shallow. The heart sounds took on a far away distinctness, later the indistinctness of being muffled. Consciousness waned. This was the condition when it was decided to explore. I have already made my confession of groping and bungling through this operation. I need not recall the sin of that here. Still, a lesson may be glimpsed from it—a lesson that may serve to drive home an earlier statement of this article. I will repeat it "The Motility of the Heart is Dogged"

CASE II—Twenty years elapsed when, again, I was confronted with the same conditions, except that the heart had been wounded by a stab. The stabbing had taken place at about five o'clock in the evening. It was eleven o'clock of the same evening when I operated on him. This operation was performed at the Good Samaritan Hospital, Portland, Oregon. The knife had entered the chest between the eighth and ninth ribs with an upward thrust to pierce the pericardium just above its base and inflict a very slight cut over the heart's apex. In fact the cut was so shallow that suturing was not necessary. It had, however, bled enough to cause a menacing compression, and we reasoned, and rightly too, I feel sure, that it was the compression that had automatically arrested the bleeding. When the sac had been slit and the incarcerated blood turned out the heart's action immediately improved. Lifting it from the sac the character of the wound was made out and seeing it had ceased to bleed, it was deemed best to let well enough alone. This case recovered.

CASE III—*Purulent Pericarditis*. It has, already, been touched upon how to secure adequate drainage in pericarditis with effusions. In this instance the compression was due to a purulent pericarditis in association with a streptococcic pneumonia which, with a pleurisy with effusion, involved the left lung. There was a leucocyte count of 38,000. We believed the fluid in the chest to be pyogenic in character, but the needle disclaimed this belief. Five pints, about, were aspirated, and the fluid being the usual pale, straw-

color, we puzzled over so high a blood count. Finally, when the signs of heart compression began to appear, and later still when it was claimed that thoracotomy was the only alternative, we found on opening into the anterior mediastinum the bulging sac. It was, to my finger-tips at least, as tense as those I had met before, but without that ugly overlying pool of blood. In color it was of that yellowish-whiteness that left no doubt as to the nature of its contents. This case I operated on at the Japanese Hospital in Honolulu. A liberal slit in the pericardium with free drainage from the anterior mediastinum through the lower border of the chondro-plastic flap brought this case to an uneventful recovery.

PURULENT PERICARDITIS IN CHILDHOOD^{*}

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DRAINAGE of the pericardial sac was first recommended by Riolan¹ in 1648, who suggested trephining the lower end of the sternum for this purpose. There is no record of Riolan having put into practice his suggestion. In 1798, a century and a half later, Desault and Larrey attempted to evacuate the pericardial sac by different routes, but both failed because of mistaken diagnosis. Laennec in 1819 again advised Riolan's plan of trephining the sternum. The first successful pericardiotomy was done by Romero,² of Barcelona, who in 1819 operated upon three patients, two successfully. He incised the chest in the fourth and fifth interspaces near the sternum. First rib resection was performed by Rosenstein, of Leyden, in 1881.²

The practice of paracentesis of the pericardium gained much impetus in America by the work of John B. Roberts³ and his report of 41 cases in 1876. The prejudice against the procedure up to this time is shown by Rogers who is quoted as saying, "Paracentesis of the pericardium remains always an operation of urgency, contra-indicated in a general way every time we have reason to suspect a case complicated with some incurable lesion, applicable especially to large acute and chronic effusions of rheumatism and to chronic effusions of which the diathetic nature is not evident. In the immense majority of cases it is only palliative." Roberts suggested the treatment of suppurative pericarditis by insertion of a drainage tube into the pericardial cavity, but apparently had not performed such operation.

The first reported case with operation is by Hilsman in 1844.⁴ From that date to 1897 Roberts⁴ collected and reported 35 operated cases, 15 recovered, 20 died.

Although comparatively few cases of suppurative pericarditis have been reported, 117 to date, it is apparently a fairly common condition. Autopsy records of the Harvard Medical School, 1896 to 1911, covering 3248 autopsies, shows 366 cases of pericarditis, 6 being purulent.⁵ Cnopf found 7 cases of suppurative pericarditis in a total of 130 autopsies. Wood⁶ reports that acute pericarditis is found in 4 per cent of all autopsies. MacLachlan⁶ reports that in the University of Pittsburgh Hospital an examination of the autopsy records shows 100 cases of pericarditis in some form in 975 cases. Very few were purulent. Whitmore⁷ reports that records of the Massachusetts General Hospital show but two cases coming to operation in thirty-two years. Records at the Children's Hospital in Philadelphia for the past thirty-two years show none but the case being reported coming to operation. Therefore the question—how many cases are being missed in all of our hospitals?

In 1897 Roberts⁴ compiled a list of all reported cases to date. He

^{*} Read before the Philadelphia Academy of Surgery, January 3 1927

reported 35 cases Porter¹² in 1900 reported an additional 16 cases In 1909, Eliot¹⁷ added 22 cases Rhodes² in 1915 reported 13 and in 1921 Poole¹⁴ brought the literature to date with a report of 13 cases I wish to add 18 cases bringing the total number to 117 Of these there were 31 patients between the age of six and twelve From sixteen months to sixteen years there were 50 cases Of the total 117, there were 63 recoveries and 54 deaths, or 54 per cent cures In the children there were 25 recoveries and 25 deaths, or 50 per cent cures By cures is meant recovery from operation and subsequent discharge from the hospital with pericardial infection cleared The details of most of these cases are meagre, so a report cannot be made on the number of cases with normally functioning hearts one or more years after operation

The cause may be direct extension by contiguity or through the blood In most cases the condition is secondary to some other focus of infection⁶ In children it usually follows acute exanthematous diseases, but may follow aseptic process anywhere in the body—such as osteomyelitis, otitis and mastoid disease Pneumococcus is the organism most frequently found Other organisms have been—staphylococcus, streptococcus, Frankel's diplococcus, *B pyocyaneus*, *B tuberculosis*, *B coli communis*, *B influenza* and rarely *B lact aerogenes* and *B proteus vulgaris* In the pneumococcal type the pus is less abundant, thick and creamy In the streptococcal there is abundant thin pus and the membrane is only slightly thickened

The symptoms are divided by Rhodes² into three stages (1) A small amount of pus present—symptoms only constitutional (2) In which there is an increase of exudate up to the limits of elasticity of the sac This is the stage usually seen—and gives the classical symptoms and signs of pericarditis with effusion (3) The elasticity of the sac is overcome by the amount of exudate, this stage is called by Rehn the "Herzdruck" It is produced by the intrapericardial pressure exceeding the intra-auricular pressure The case to be reported illustrated this stage when one day near the close of the drainage period, on irrigating the sac with a tube that did not allow free return of the fluid, the patient suddenly became cyanotic, showed great respiratory embarrassment, the veins of the neck became distended, pulse irregular and complaint made of precordial pain, oppression in the chest and pain in the left arm Rhodes² reports a similar experience, as do also Blake and Parker

A diagnosis is made by the history, recent infection, fever, usually septic in type, rapid pulse, dyspnoea, restlessness possibly cough, and precordial, epigastric or abdominal pain⁹ If moderate effusion—palpitation, dyspnoea, and increase of respirations do not occur The pulse is rapid but regular As effusion increases dyspnoea, orthopnoea cyanosis, and rapid, irregular heart occurs There is high fever and sweating in septic cases⁶ Wynter¹⁰ states that loss of abdominal respiratory movement is an accompaniment of pericarditis The X-ray aids greatly in arriving at a diagnosis The physical signs are those of pericarditis with effusion and need no discussion The

condition most frequently confused with pericarditis with effusion is dilated heart Roberts⁴ urged exploratory incision down to the heart in patients with urgent symptoms that might be due to either condition—then aspirate if no pus and drain if pus

The question of paracentesis in either diagnosis or treatment is an interesting one Rhodes² states that it is emphatically condemned LeConte¹¹ says exploratory puncture is an essential procedure in making a diagnosis Roberts⁴ prefers incision and exploration rather than aspiration The dangers are, puncture of the internal mammary artery, puncture of the heart muscle or large vessels and the lung The danger most frequently dwelt upon is that of puncturing the pleura and carrying the infection into the pleura and lungs Sick¹² found in the adult that out of 23 cases, in 17 the pleural reflection at the level of the fifth rib cartilage lay at or within the sternal border, and in 12 children it was in the same location in 11

The site of puncture is another point of great variance Roger³ advises the fifth interspace midway between the left nipple and the sternum, penetrating directly backward Dieulafoy—the fifth interspace three-quarters of an inch from the edge of the sternum, because experiments conducted by him showed the greatest amount of distention here Hobart A Hare, Delome and Mignon prefer the sixth interspace Laennec, Boyer, Richerand, Muller and John B Roberts¹ prefer the left costoxiphoid notch close to the ensiform cartilage, etc

Treatment consists of incision and drainage Klose and Strauss²⁰ collected a series of 93 cases and reported that of 29 cases treated by puncture alone but 4 recovered Of 27 treated by intercostal incision 10 recovered Of 37 treated by wide exposure of the pericardium 21 recovered Whitmore⁷ reports a case successfully treated by the closed suction method He describes his operation as follows "Novocaine anæsthesia Incision three-quarters of an inch long in the fifth interspace just inside the border of dulness Anæsthetize muscles, pericardium and pleura, if in the way Push a large trocar, with cannula large enough to carry a No 10 French catheter, through the pericardial wall Quickly slip No 10 French catheter, with end closed by a hæmostat, through the cannula Push the catheter in far enough for the tip to go around the apex of the heart and half-way up to the base (8-9 inches from the skin) Sew catheter in tightly Make suction with a large glass syringe and allow no air to enter the pericardium Empty pus slowly Suction is done every one to two hours for the first twenty-four hours, and then every two hours until but 3 to 4 c c is obtained at a time Then lengthen the time to three or four hours and later to twice in twenty-four hours When the amount is only 1 to 2 c c in twenty-four hours and this amount does not increase for four days, the catheter is removed" In the case reported the catheter was removed at the end of the fourth week It is doubtful if this treatment would be successful after fibrin has formed, and as but few cases are seen in the hospital before this stage is reached, it will be seen that it has a definite limitation

The treatment of greatest value is the removal of one or more costal cartilages, and in some instances removal of a section of the adjacent sternum. Doctor Brown, in the case to be reported, following the method of Durand,¹ resected the fifth costal cartilage and a section of the adjacent sternum. Very good drainage was obtained and the opening was large enough to permit ready identification of the various structures so that the pleural reflection was not damaged. Durand and Wertheimer¹ treated their case by resection of the seventh costal cartilage and the lower portion of the sternum. Poole,¹⁴ in his recent survey of the subject, suggests resection of the fifth, sixth and seventh costal cartilages adjacent to the sternum. He feels it is essential to have drainage in the most dependent portion of the sac. Roberts⁴ suggests a chondroplastic operation—resection of the fourth and fifth costal cartilages on the left side of the sternum and turning the flap of cartilages, muscles, and skin upward. He does not think it is essential to have drainage at the most dependant portion. Porter¹² advocates incision from the middle of the sternum out over the fifth cartilage and resection of the fifth cartilage from sternum to rib.

The advantage of a drainage tube inserted into the pericardial sac is doubtful. In most of the reported cases this was not used. Drainage was provided for by making adequate opening and suturing the edges of the incised pericardium to the skin opening. It seems to the author that the movements of the heart tend to preclude the formation of pockets. Most observers have noted that in effusion the heart is pushed forward against the anterior chest wall. Therefore if at the time of the operation all pockets are broken down they probably will not reform.

Poole¹⁴ advocates the treatment of these cases by the Carrel-Dakin method. In Doctor Brown's case the pericardial sac was irrigated with warm normal saline solution until the twenty-fourth day. As the fibrin seemed to be accumulating, rather than decreasing, it was decided to use the Carrel-Dakin treatment with result that the amount of fibrin and discharge began to show a marked decrease and the patient's temperature began to assume a downward trend. Roberts and others agree that there is no good reason to suppose that irrigation with a mild antiseptic causes any cardiac disturbance. He suggests that this is so because the reflex irritability of the heart is modified by the false membrane.

Jopson¹⁶ in discussing Poole's paper, when read before the Academy of Surgery (Philadelphia), reported a case in which he tried Carrel-Dakin treatment, but discontinued it because the thick mixture of the exudate and solution caused embarrassment to the heart's action.

Beck and Moore,¹⁵ in recent experiments on the normal pericardium, conclude that it is a delicate structure and that slight irritation, even irrigation with warm normal saline, usually results in firm adhesions between the two layers. This evidently does not apply to the infected pericardium for in the case to be presented, there is to-day no evidence of a heart crippled by adhesions to surrounding pericardium.

PURULENT PERICARDITIS IN CHILDHOOD

Hall¹⁶ reports a case, diagnosed acute septic pericarditis, which yielded to intravenous injection of 15 c c of a 1 per cent solution of mercurochrome. The patient had had a tooth extracted five days previous. There is no record of a culture on this admission to the hospital and no record of a paracentesis to confirm the diagnosis.

The treatment of the infected pericardium is not sufficient in the treatment of these cases. It is likely that in all these patients the myocardium is markedly diseased, as evidenced by palpitation, tumultuous heart action, dyspnoea, tendency to syncope, cyanosis and finally signs of cardiac failure, as anasarca and ascites. Doctor Brown's patient showed this condition to a marked degree and required frequent tapplings, and energetic medical treatment. To the cases previously reported I add the following:

White male, age seven years. Admitted to the Children's Hospital in the service of Dr Henry P. Brown, Jr., September 26, 1925. Temperature 99.6, pulse 144, respiration 40. Previous history, negative except for pertussis several years ago.

Present illness (as given by the mother). Onset seven weeks ago with cervical adenitis followed by ptomaine poisoning, vomiting and urticaria. This was followed in a few days by abscess on left shoulder, posteriorly. Taken to another hospital where a diagnosis of pneumonia was made. The child was critically ill and the parents were told nothing could be done for the child and they took him from the hospital.

History in this hospital shows the patient was admitted August 27 with temperature 104, pulse 100, respiration 32. He had a fluctuating tumor over the left scapula which was incised but no pus obtained. A note on the chart stated the contents appeared to be gelatinous. Following this he had symptoms and findings in the left chest thought by some of the men to be patches of pneumonia. During this time his temperature fluctuated from 101 to 98.4. On September 2, X-ray men reported, "Heart shadow not enlarged. Left lung shows area of consolidation from root to base upper lobe, suggestive of encapsulated abscess."

Repeated exploratory punctures of the left chest failed to reveal pus. Some thought the mass in left chest involved mediastinal tissues and not heart nor lungs.

September 4 the pulse rate jumped to 150 and remained up.

X-ray on September 25 showed heart shadow enormously enlarged to the left.

Diagnosis of serofibrinous pericarditis was made and the parents removed the child against advice of the physicians. Paracentesis pericardii was not made.

Examination on admission showed an emaciated boy who appeared to be critically ill. He was cyanotic, breathing was difficult and rapid. Frequent hacking cough. Anxious expression. Very restless. Skin dry. Conjunctivæ reddened. Pupils dilated. Nares dilated with each respiration. Marked pulsation in vessels of the neck.

Chest shows rapid respiratory excursions. Breathing entirely thoracic. Recent crucial scar over the left scapula. Skin over chest, mottled and dry. Resonance impaired at left base anteriorly. Many fine, crackling râles over both bases and extending to axilla. No evidence of fluid in pleural cavity.

Heart—dulness markedly enlarged to right and left. Sounds, distant and irregular. Unable to elicit friction rub or murmurs. Apex beat, not visible. Posteriorly there was area of dulness in region of the angle of the scapula.

Abdomen, somewhat distended. Liver edge, four fingers' breadth below the costal margin, edge smooth, rather tender. Spleen and kidneys not palpable.

X-ray on admission, September 26, 1925, by Doctor Bromer, reports, "Marked increase in density in left chest from apex to diaphragm. Right lung shows less increase in density from apex to seventh rib. There is extreme increase in the width of the right

auricle shadow, and of the left ventricle, and also of the base of the heart I think this is due to a pericardial effusion Lung density could be due to a passive congestion"

September 27—Coughs considerable, non-productive No pain

September 28—Paracentesis pericardii, fifth interspace close to the sternum, by Doctor Reilly, 7 or 8 ounces thin purulent fluid removed, with quite marked relief of symptoms

September 30—Dr H P Brown under novocaine anæsthesia resected the fifth costal cartilage and adjacent portion of the sternum Internal mammary artery ligated Pleural reflection pushed aside Pericardium incised Culture taken Considerable thin purulent fluid allowed to slowly escape Pericardial opening edge sutured to skin edge Large rubber drain inserted through the chest wall to the inner level of the pericardium Rest of wound closed with silkworm gut sutures Child stood the operation well and returned to the ward in fair condition Culture—*Staphylococcus aureus*, hæmolytic

Progress—October 1—Child sleeps fairly well in sitting position Pulse 160, temperature 101, respiration 34, pulse intermittent, but volume fair Forcing fluids

October 3—Wound draining freely General condition much improved Pulse intermittent, rate 100 Liver three fingers below costal margin Spleen not palpable Given digitalis in large doses

October 5—Pulse 160, temperature 103, respiration 48 Child coughing a great deal Wound draining moderately Irrigated with warm saline Considerable fibrin present

October 7—Quite ill Given blood transfusion, father's blood General condition improved following transfusion

October 9—Pulse again very rapid and weak Patient's condition is grave

October 13—Large amount of fibrin about the opening of the cavity Temperature has been fluctuating between 103 and 99 Curved hæmostat passed through opening, behind the heart and opened failed to reveal any pus collection

October 17—Quite weak Considerable discharge from the wound Given more stimulation—chiefly whiskey and digitalis

October 22—Discharge less in amount but contains considerable fibrin Temperature still fluctuating from 103 to 99 Pulse from 160 to 120, but is more regular, skipping beat but once in 40 beats There has been œdema of right forearm for past three days Right chest aspirated in posterior axillary line, seventh interspace, and 480 c c clear, straw colored fluid removed Two Dakin tubes were inserted through pericardial wound and carried just into the sac Carrel-Dakin treatment started

October 26—Discharge less and thinner Temperature fluctuating from 100 to 98.2

October 28—General condition much improved Right chest aspirated and 480 c c straw colored fluid removed Liver extends to within (1½") of umbilicus

October 30—Discharge small in amount, thin Smears show 8-10 organisms to a field Breathing much easier

November 5—Very little discharge Cultures show slight growth—*staphylococci* Right chest aspirated—300 c c straw colored fluid removed Pulse still around 140 Temperature 98-99

November 6—Smears show but 1 or 2 organisms to a field Dakin tubes removed

November 10—Temperature normal Pulse 130 There is a swelling in right side of neck about the size of a pigeon's egg—under the sterno-mastoid muscle, slightly tender Patient complained of pain and tenderness in calf of right leg—no swelling Liver two inches from umbilicus When pericardial sac was irrigated 20 c c Dakin's solution was put in, but the tube did not permit free exit of the fluid and patient went into the state of so-called, "Herzdruch"—becoming dyspnoic, cyanotic, and complaining of pain in left chest and abdomen He was relieved by permitting free exit of the fluid

X-ray shows heart shadow much reduced in size Less fluid in right chest

November 14—Swelling noted on November 10, has disappeared Patient permitted out of bed in chair Sinus still present—very little clear discharge

November 16—Wound healed Probed, when one dram of clear fluid was obtained
Right chest aspirated—300 c c clear fluid removed

November 19—Pulse now quite regular, rate 120 General condition good

December 8—Patient up and about the ward Gaining weight Lungs show good expansion—no evidence of fluid in pleural cavities Heart—area of dulness but slightly increased Wound healed Pulse rate 90–110, regular and increased but slightly on exercise Liver still a little enlarged

December 17—Discharged Gaining weight Color good Quite active and pulse remains regular, rate 86–96 Heart regular, sounds clear, no friction, no retraction of superficial structures Liver almost normal in size, not tender No œdema of extremities Referred to heart clinic for observation Weight on discharge, 47 pounds

February 6, 1926—Notes from heart clinic Weight 55 pounds 6 ounces General condition good Cardiac dulness in fourth interspace is 7 cm to left and 3.5 cm to right of mid-sternum

March 3, 1926—Heart slow and sounds clear No evidence of faulty action of the heart

November 13, 1926—Seen by Doctor Brown General condition excellent Heart action regular, no evidence of pericardial adhesions No dyspnoea on exertion Gaining weight Mother states he was never better

REPORT OF CASES REPORTED SINCE THE PAPER OF POOLE¹⁴ IN 1921

1 DURAND and WERTHEIMER¹⁵ report case of male, age thirty-seven Operated nine days after admission (August 9, 1919) Patient had infected hemopericardium after stab wound Treated by resection of seventh costal cartilage and lower portion of the sternum Recovery

2 CASSIDY, M. A., MOON, R. O., PEELY, F. LEQ¹⁶ reports male forty-two, who was seen in attacks simulating Angina-pectoris There was history of three separate attacks of gonorrhœa in two years He died three days after admission No operation Autopsy revealed suppurative pericarditis, thought to be gonorrhœal in origin

3 WHITEMORE⁷ reports boy, age twelve years Seen May 8, 1920 Previous history of measles with normal convalescence On April 27, day following recovery from measles, he was taken with sudden chill and high temperature On May 8, pneumonia right base and empyema left side chest Closed suction operation On May 15, temperature 100–102, respiration 35, pulse 110 X-ray showed heart shadow enormously increased Aspiration revealed thin pus Culture, pneumococcus type 1 Drainage by closed suction Good recovery Patient had to have bilateral mastoid operation before discharge from the hospital

4 KLOSE, H., and STRAUSS, H.²⁰ operated on a man of forty-one years, who had marked adhesions to surrounding mediastinal structures He died a few days later

5 and 6 HILSE²² reports two cases in which there were adhesions between the heart and pericardium One, male nineteen, operated on by Ollier's method, died The other a male, age twenty-seven, operated upon by Rehn's method got well although examination on discharge from the hospital showed retraction of the chest wall and diaphragm with each heart beat

7 GAMBERINI²¹ operated on male, age seven years A second operation was necessary sixteen days later because of insufficient drainage At second operation a section of the sternum was resected and drainage was instituted posterior as well as anterior Fistulæ persisted for some time—5 or 6 months There was recovery with good health four years later

8 In APFEL'S⁶ case, a boy age twelve years, a pulsating mass appeared at the left border of the sternum at fourth costal cartilage This was found to be infected pericardium and was drained Patient died

9 ORSINI²² reports male, age sixteen years, admitted December 3, 1921 with signs of pneumonia Aspiration on December 23 revealed pus in the pericardium Patient died

10 and 11 JOPSON¹⁸ and MULLER⁷¹ in discussing Poole's paper each reported a case, Muller's patient, male of sixteen years, recovered Jopson's patient, adult male, died

12 DUIOUR and BARUK²⁶ report a patient, age twenty-two, admitted to the hospital with vomica Pleural cavity explorations were negative Paracentesis pericardii revealed purulent fluid He died without operation Autopsy showed communication between posterior portion of pericardial sac and bronchi

13 MUNIAQURRIA and ZENO²⁷ Male, four years Pericardiotomy with drainage on July 12, 1923 Good recovery Child showed positive tuberculin test and was thought to have pulmonary tuberculosis Question if pericardial condition was of tubercular origin

14 COTLIN, MILE and GANTIER²⁸ through the fourth interspace aspirated the pericardium a number of times in a male, six and one-half years old Recovery

15 HALL and TOWNROW²⁵ report, male seventeen, who was admitted to the hospital on September 26, 1923, with primary pneumococcal pericarditis Paracentesis pericardii gave considerable relief Paracentesis on October 1 was followed by resection of the fifth rib and drainage Empyema of left pleura, thought to be secondary to the pericardial infection was drained on October 31 Patient was discharged December 11 and was in good health one year later

16 WOOD and BRADLEY⁶ had a patient, male, age four years and nine months, admitted April 8, 1923, following measles Diagnosis on admission, broncho-pneumonia April 12 they drained the second left interspace for a collection of pus Drainage ceased in five days Needle inserted deeply through the wound revealed more pus Pericardiotomy on April 21, after resection of the third rib Irrigated with Dakin solution Drainage poor and wound had to be opened several times Wound healed and on May 6 patient was discharged in good condition

17 ADSHEAD²⁰ in Royal Naval Service treated male twenty-two years who was admitted to the hospital with double pneumonia on April 18, 1925 On May 1 pericardial effusion was noticed Paracentesis pericardii on May 3, pneumococcic pus, fifth left costal cartilage and part of the rib was resected on May 4 Pericardial sac irrigated with acriflavine and hypertonic salt solution for three weeks Patient developed general ascites and urine showed cloud of albumin and red blood cells Ascites aspirated July 24 a large abscess posteriorly between the base of the lungs and dome of the diaphragm was drained This was followed by speedy recovery

18 Doctor Brown's patient—case reported

REFERENCES

- ¹ Keen's Surgery, vol v, p 17
- ² Rhodes, G C ANNALS OF SURGERY, 1915, vol 1xii
- ³ Roberts, John B Paracentesis of Pericardium N Y Med J, 1876
- ⁴ Roberts, John B Surgical Treatment of Suppurative Pericarditis Am Jour Med Sc, 1897, vol cxiv, pp 642, 664
- ⁵ Apfel, H Arch Pediat, August 1923, vol xl, pp 519-524
- ⁶ Wood, A C, and Bradley, W N Atlantic M J, April, 1925, pp 436-445
- Whitemore Surg, Gyn and Obst, 1921, p 371
- ⁸ MacLachlan, W W G Pericarditis Incidence and Diagnosis Am Jour M Sc, Phila, 1921, vol clxi, pp 654-668
- ⁹ Talley, James E Physical Examination of Heart in Children Arch Ped, 1915
- ¹⁰ Wynter, W Essex Clin Jour, London, June 10, 1912
- ¹¹ LeConte Am Jour Med Sc, 1904 vol cxxviii
- ¹² Porter C B Suppurative Pericarditis and Its Surgical Treatment ANNALS OF SURGERY, 1900, vol xxii, p 769

PURULENT PERICARDITIS IN CHILDHOOD

- ¹³ Durand, M, and Wertheimer, P Lyon Chir, March-April, 1920, vol \ \ \ \ \, p 206
 Ab J A M A, August 28, 1920, vol I \ \ \ \ \, p 639
- ¹⁴ Poole, E H ANNALS OF SURGERY, April, 1921, vol I \ \ \ \ \, p 393
- ¹⁵ Beck, C S, and Moore, R L The Significance of the Pericardium in Relation to
 Surgery of the Heart Arch Surg, October, 1925, vol \ \ \, p 550
- ¹⁶ Jopson, J H Discussion of Poole's Paper Tr Phila Ac Surg, vol \ \ \ \ \, p 166
- ¹⁷ Eliot, E J ANNALS OF SURGERY, 1909, vol \ \ \ \ \, pp 60-85
- ¹⁸ Hall, C H W Virg Med Jour, May, 1925, vol \ \ \, pp 245-247
- ¹⁹ Cassidy, M A, Moon, R O, Peely, F LeQ Lancet, September 10, 1921, vol \ \ \, p 559
- ²⁰ Klose, H, and Strauss, H Arch f Klin Chir, April, 1922, vol c \ \ \ \ \, pp 467-519
 Ab J A M A, July 1, 1922, vol I \ \ \ \ \, p 83
- ²¹ Gamberini, C Arch ital di chir, January, 1923, vol v \ \ \, pp 619-630 Ab J A M A,
 April 28, 1923, vol c \ \ \ \ \, p 1274
- Hilse, A Deutsche ztschr f chir, 1922, vol c I \ \ \ \ \, pp 1-14 Ab J A M A,
 March 17, 1923, vol I \ \ \ \ \, p 808
- ²² Olsini, P Riforma Med Napoli, 1922, vol \ \ \ \ \ \ \ \ \ \ \ \ \ \ \, pp 1188-1190
- ²³ Muller, Geo Tr Phila Ac of Surg, vol \ \ \ \ \, p 164
- ²⁴ Hall, A J, and Townrow, V Brit M J London, 1924, vol \ \ \, p 1148
- ²⁵ Dufour, H, and Baruk, H, Bull et mem Soc med d hop de Par, 1924, No 3, vol
 xlviii, pp 744-747
- ²⁶ Muniaqurria, C, and Zeno, A Rev Med del Rosario, 1923, vol \ \ \ \ \, pp 384-392
- ²⁷ Cotlin, Mlle E, and Gantier, M P Arch d mal du coeur, etc, Par, 1923, vol \ \ \ \ \, pp
 651-658
- ²⁸ Adshead, G P J Roy Nav M Serv, London, 1926, vol \ \ \, pp 57-59

PHLEGMONOUS GASTRITIS¹

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PHLEGMONOUS gastritis is a rare condition described since ancient times, beginning with Galen. It is an infection of the stomach wall characterized by sero-purulent or fibrino-purulent inflammation, chiefly localized in the submucosa, but more or less involving other layers. It may occur either as a phlegmon or as an abscess or as a combination of the two. The phlegmon may be diffuse or circumscribed. In ancient literature, only the abscess form was recognized.

The first accurate pathological description of a phlegmon was made by Cruveilhier (1820). In Raynaud's collection (1861) half the cases were abscesses, and the other half phlegmons. Later, with the advent of abdominal surgery, phlegmons were more easily recognized so that in Sundberg's collection of 215 cases (1919), 85 per cent represented phlegmons, 12 per cent abscesses, and 3 per cent a combination of the two. Of the 185 phlegmons, 158 were diffuse, and 27 circumscribed.

With the larger material available during recent years, it is apparent that the process may vary greatly in its intensity, as illustrated by certain subacute and chronic types to be mentioned later.

The acutely inflamed stomach wall is usually dense and rigid,² but in some cases may be of soft, spongy consistency. Thickening of the wall may be little more than normal, or may reach a degree described in Hall and Simpson's case, where relative size of wall and cavity bore a striking resemblance to that of the uterus. Circumscribed phlegmons and abscesses occur more frequently in the pyloric region than elsewhere. Abscesses of the stomach wall have been known to reach the size of a Bartlett pear. While most phlegmons can be diagnosed grossly, a definite number of others merely show an acute swelling, the character of which can only be determined by microscopical examination.

The mucous membrane is at times unchanged, both on gross and on microscopical examination, at other times, all varieties of thickening and all degrees of œdema as well as hyperæmia, punctiform hemorrhages, hemorrhagic erosions, and ulcerations, may be found. Moreover, there may be perforations of the mucosa, thus permitting spontaneous drainage into the gastric cavity. Involvement of the muscularis and serosa is common. Peritonitis occurs in from 60 to 70 per cent of the cases, but is not invariable. In one-third of the fatal cases there was no peritonitis (Sundberg). Left-sided pleurisy, pericarditis, and bronchopneumonia have been complications.

¹ Read before the New York Surgical Society, January 12, 1927.

² Virchow, at the autopsy on a case of Ackerman's, remarked that if such a condition involved the skin it would be called a carbuncle.

Streptococci are the organisms most frequently found (70 per cent), but staphylococci, pneumococci, *B. coli*, and *B. subtilis* also occurred.

Phlegmonous gastritis occurs mostly in the working classes, and is three times as frequent among men as among women. The majority of the patients are between twenty and sixty years of age.

As constitutional predisposing causes may be mentioned, exhaustion from hard labor, alcoholism, chronic gastritis, and hypoacidity of the gastric juice. The bactericidal properties of normal gastric juice and, conversely, the increased likelihood of infection definitely associated with low acid figures, must both be taken into account. Sundberg states that there was no history of hyperacidity or even of normal acidity of the gastric juice in the cases he reviewed. This observation is confirmed in a majority of the cases which the author has been able to collect since that time, in which gastric analyses were reported. In this connection a report of Stieda is of interest. In 64 cases of gastric operation on patients with low acid values, post-operative infections developed in 17 (30 per cent), while in 35 cases in which the acidity was high or of normal value, there were only 2 (6 per cent) cases of infection.

Bumm's recent experiments *in vitro* demonstrate the antiseptic qualities of normal gastric juice. He maintains that in anacid stomachs bacteria remain alive. If stagnation be present, the products of decomposition favor bacterial growth and increased virulence.

There are a few instances in which trauma has played a definite etiological rôle. In chronic gastritis the mucosa is more susceptible to trauma than when normal, and it must also be remembered that streptococci can penetrate mucous membrane without causing a local reaction at the point of entry. Actual injury to the gastric mucosa by chemicals and drugs or by the poisons of spoiled food (see below) is occasionally noted in the etiology. External trauma, such as that caused by the kick of a horse or a fall from a scaffold, striking the epigastric region, is of occasional etiological importance. Gastric phlegmon has been associated with ulcer or cancer of the stomach in over 50 cases.

Phlegmon of the stomach rarely occurs as part of a general sepsis with purulent metastases in various organs. On the other hand, certain unknown predisposing factors may exist, for it was noted that during a large epidemic of puerperal sepsis in Prague in 1847, several cases of phlegmonous gastritis were observed among those coming to autopsy. Cases of phlegmonous gastritis are also seen following erysipelas³ or furunculosis.

A man of forty-nine years (reported by Sundberg), suffering from chronic pulmonary tuberculosis, after five days' ingestion of potassium iodide, developed a severe pustular acne, his general condition became poor, and he died within a week. At autopsy a large recent ulcer at the pylorus was found, while in other parts of the mucosa there were areas of suppuration varying in size from a pea to an almond, with

³ See Cases Nos. 45, 46 and 47 in appended table more fully reported as Cases I, II and III in text.

⁴ See Cases Nos. 10 and 45 (Case I in the text).

small perforations into the lumen of the stomach. Similar lesions existed in the duodenum and upper jejunum. These suppurative foci grossly resembled the acne pustules of the skin and the larger ulceration at the pylorus was held to represent a carbuncle. Microscopical examination of the uninvolved gastric mucosa showed chronic gastritis.

Besides erysipelas, furunculosis, and puerperal sepsis, as just noted, gastric phlegmon has occurred in connection with smallpox, scarlet fever, acute polyarthritis, and pyæmia.

Direct contact of the gastric mucosa with infectious material has also been followed by phlegmon. For example, it has occurred after tonsillitis, stomatitis, pharyngitis, purulent bronchitis, drainage of abscesses of the oral pharynx, and extraction of carious teeth. In one case it followed a meal of calf's liver from an animal which had probably died of sepsis. In another instance, all the guests at a party became gravely ill after a meal, but only one died, and autopsy showed a phlegmonous gastritis.

Lastly, there is a large group in which no ascertainable cause exists—the so-called primary idiopathic form.

The typical symptoms are sudden onset, with profound prostration, high fever, chills, intense epigastric pain and tenderness, repeated severe vomiting, and more or less local rigidity. A symptom first noted by Deiningger (1879) and occasionally confirmed since then is lack of pain when the patient is made to sit up. This symptom was observed by Sundberg independently. In some cases of spontaneous recovery from gastric abscess, a definite tender epigastric tumor has developed in the course of days, and spontaneously subsided after the vomiting of pus. Graphic descriptions of these are quite frequent among the earlier reports.

The vomiting of macroscopic pus or the presence of bacteria in the vomitus are rare. Macroscopic pus in the stools has occasionally been noted. As a rule, the white blood cell count is high—between 20,000 and 30,000. Extreme restlessness up to within a few hours before death has been noted, in other cases there was marked apathy.

Diagnosis is rarely made before operation. Usually the condition is mistaken for acute perforated gastric ulcer, acute pancreatitis, or acute cholecystitis. High fever and lack of increased pain upon sitting up (Deiningger's symptom) speak for gastric phlegmon as against perforated gastric ulcer. Before the onset of peritonitis (as noted elsewhere this was absent in one-third of the fatal cases) abdominal puncture would be negative, both in phlegmonous gastritis and in acute pancreatitis. Abdominal puncture after the onset of peritonitis would exclude acute pancreatitis. With the abdomen opened, the condition has been recognized in the acute fulminating type by a number of observers. On the other hand, it has been mistaken for a neoplasm in chronic cases, and only upon examination of the resected specimen has the actual diagnosis been made. Aspiration of pus from the thickened gastric wall with a fine needle has been of diagnostic aid a number of times.

The average duration of the disease is one or two weeks, but several deaths have occurred within a few hours of onset. The mortality is 92 per cent (Sundberg).

Regarding surgical efforts to control this condition, it may be noted that success has been reported following simple drainage down to the gastric peritoneum, gastrostomy, and gastro-enterostomy, but these cases may be classed as examples of spontaneous recovery. There have been eight successful resections if we include Cases IV and V of Bircher for so-called gastritis putrida, which he maintained is a beginning stage of phlegmonous gastritis. The successful cases of Koenig (one, 1911) and Dahlgren (two, 1918) were of long standing and afebrile, and the pre-operative diagnosis was carcinoma. Zoeffel's (1913) patient was ill for six days, there was no fever, the pulse was 64, and the pre-operative diagnosis was slow perforation of a gastric ulcer. Orator (1926) operated for acute perforation of a gastric ulcer on the greater curvature, 19 cm. from the pylorus, around which was an area of circumscribed phlegmonous gastritis the size of a saucer. The two successful resections of Bircher for gastritis putrida were done on chronic cases with pre-operative diagnoses of pyloric stenosis. Novak (1919) successfully performed pylorotomy for a large submucous abscess.

The recent important contribution of Orator, from Von Haberer's clinic, draws attention to phlegmonous gastritis of the stomach as a post-operative complication. Four cases are reported. The first followed gastro-enterostomy for an inoperable carcinoma of the pylorus in a young woman. The second case was that of a man of twenty-nine. Gastro-enterostomy for duodenal ulcer had been done in 1919, jejunostomy for gastrojejunal ulcer with dense extensive adhesions in 1921, and subtotal gastric resection for gastrojejunal ulcer in 1922. There followed a phlegmonous infiltration of the submucosa around the anastomosis which involved the seromuscularis, causing a fatal peritonitis. (The total acidity varied from 62 to 74 in this case.) The third case followed resection (Billroth II) for a chronic ulcer diagnosed as carcinoma.⁷ The fourth (Orator's own) was that of a man of forty, on whom a Billroth I resection for duodenal ulcer was done. The patient died on the fifth day with signs of gastric retention. Autopsy showed a greatly dilated stomach, there was no leak at the suture line and no peritonitis. The duodenum and jejunum were dilated up to a point 20 cm. beyond the duodenal-jejunal flexure. Grossly, there was marked swelling of the gastric wall, but only on microscopical examination was it ascertained that a typical phlegmonous gastritis existed. Orator points out that such post-operative inflammatory changes (of a less severe character) may occur more often than one would imagine. Moreover, it is possible that such inflammatory reactions confined to the region of a gastro-enterostomy opening may constitute a predisposing factor for subsequent development of peptic ulcers in this locality. Therefore, he advises routine microscopical examination of stomach tissue from those dying with the symptoms of persistent gastric dilatation, especially when peritonitis is absent.

In every large series of gastric carcinomata there are reports of patients who remained well years after palliative operations. It has been noted above

⁷ These three cases occurred at Von Eiselsberg's clinic.

that the pre-operative diagnosis in the cases of Koenig and Dahlgren was tumor, and that only after resection was the true condition recognized. Orator cites the case of a man of sixty-three with an apparently inoperable carcinoma growing to the anterior abdominal wall, arising from the lesser curvature with involved lymph-nodes reaching to the cardia, for which gastro-enterostomy with entero-anastomosis was performed. Seven years later the patient reported himself in good health.

The extensive inflammatory changes noted in *limitis plastica*, which often are extremely difficult to distinguish from scirrhus carcinomatous involvement, may represent the final stage of a subacute diffuse phlegmon of the stomach.

Lastly, among a large series of resected stomachs Orator found four cases of hour-glass contracture, in which submucous cicatricial changes extended far beyond the customary distance of involvement around ulcers—conceivably the end-stages of healed phlegmons.

The case of Stapelmohr (40 in the appended table) seems to prove this point. A woman of forty-eight years was operated on eleven days after the onset of symptoms. A phlegmonous gastritis was found, the inflammation involving the omentum, transverse colon, mesocolon, and gastrocolic ligament. Pus aspirated with a fine needle from the gastric wall showed streptococcus and *B. subtilis*. Five years later examination of the patient, who was then in perfect health, showed absence of free hydrochloric acid and an hour-glass contraction of the lesser curvature.

From the foregoing evidence one must conclude with Sundberg and Orator that there are many cases of phlegmonous gastritis which recover and are not diagnosed as such.

In 1919, Sundberg published a most comprehensive monograph which included a review of 215 cases. In addition to these, the author has been able to collect 48. Of this number, 5 cases were found among 5200 autopsies at Mount Sinai Hospital. The material from one case has previously been demonstrated and appears in the literature. The four others are now published for the first time. A surgical summary of these 263 cases is appended. In passing, it may be mentioned that among 1200 autopsies at the Lenox Hill Hospital no example of phlegmonous gastritis was encountered.

The five case histories and autopsy reports from Mount Sinai Hospital follow in brief.

CASE I—*Phlegmonous Gastritis, Ulcer, Erysipelas*—Solomon W., fifty-two years, admitted to the medical side of Mount Sinai Hospital, July 8, 1909. Previous history was negative except that the patient had been in the habit of taking two or three whiskies daily before meals. There was also a history of erysipelas of the leg five weeks before admission.

The present illness began five days before admission, with sharp epigastric pain, frequent vomiting, chilly sensations, but no actual chill, and high fever. The patient was markedly prostrated, but after three days felt better and got out of bed, weak but comfortable. The pain returned twelve hours before admission, with fever, marked prostration, and dyspnea. The hands and feet were blue. There was a diffuse erythema over the entire body.

Physical examination showed an almost moribund man, with marked dyspnoea and cyanosis, the pulse was rapid and weak. In the upper abdomen there was a firm, exceedingly tender, smooth mass, filling the entire epigastrium. The abdomen was moderately distended, but there was no free fluid. The legs showed healed ulcers, with irregular, well-defined, dull bluish areas around them. The patient died two hours after admission.

Autopsy No 1802. Serous peritonitis. Lower end of œsophagus involved (4 cm from cardia). Entire stomach wall thickened and œdematous. Small ulcer on greater curvature, 5 cm from pylorus. Duodenum normal.

Microscopical examination. Acute suppuration of all coats of œsophagus and stomach, except mucous membrane, which was slightly involved.

Culture from submucosa of stomach showed streptococci. Spreads from involved areas of leg and thigh after long search showed single chain Gram-positive cocci.

CASE II—*Phlegmonous Gastritis, Peptic Ulcer, Gastro-enterostomy*—Clara S., single, twenty-seven years, admitted to Mount Sinai Hospital (service of Dr Alfred Meyer), June 29, 1913. No previous history of gastric trouble.

Six days before admission the patient suffered from headache and fever, no chills. For the first three days she vomited three or four times daily, on the fourth day vomiting was incessant. The vomitus was foul smelling and dark green, no blood was present at any time. There was no pain and no jaundice.

Physical examination on admission showed abdomen lax. There was slight tenderness over gall-bladder. Meltzer test positive. Rest of examination was negative. The temperature on admission was 104. Blood count gave white cells 20,000, polymorphonuclears, 81 per cent. The temperature varied from 100 to 105 daily.

On July 3 the patient was seen by Dr A. V. Moschcowitz who made the diagnosis of probable appendicitis, with possible complicating pyelophlebitis, and advised operation. The patient was transferred to the service of Dr A. G. Gerster. The white blood-cells then were 22,900, polymorphonuclears, 87 per cent.

At operation the same day (Doctor Moschcowitz) the stomach was found matted to the duodenum with yellowish-green fibrin, which extended along the greater curvature towards the cardia. The stomach and duodenum were markedly thickened, œdematous, and friable. A posterior gastrojejunostomy was established, with local drainage. The patient died at 1 P.M., July 4.

Autopsy No 2371. Plastic peritonitis over upper abdomen. Gastro-enterostomy. Pyloric ulcer. The submucosa of entire pyloric end of stomach infiltrated with purulent exudate. Several abscesses surrounding ulcer.

Cultures showed streptococci.

CASE III—*Phlegmonous Gastritis, Pyloric Ulcer, Healed Duodenal Ulcer*—Jacob K., forty-eight years, admitted to Mount Sinai Hospital (service of Dr A. A. Brill), July 19, 1915. Previous history was negative. Present illness began six days before admission when transient frontal headache developed. Two days later, headache recurred, and there was sudden onset of severe epigastric pain with an attack of vomiting. Pain continued. The patient vomited three times two nights ago. There had been no bowel movement. The night before admission the stomach tube was passed but there was no return.

Physical examination on admission showed a moribund man, with signs of pulmonary œdema and peritonitis. The temperature was 103.6. The patient died three hours after admission.

Autopsy No 2544. Sanguino-purulent fluid in peritoneum, containing streptococci. Phlegmonous gastritis of entire stomach involving all walls, especially the submucosa and mucosa. Old ulcer at pylorus. Healed ulcer of duodenum.

CASE IV—(Same as Case No 14 of summary)—*Phlegmonous Gastritis*—Nathan P., sixty-five years, admitted to Mount Sinai Hospital (service of Dr A. V. Moschcowitz), May 14, 1917 at 11.30 P.M. Previous history negative.

TABLE II
Summary of 48 Cases of Phlegmonous Gastritis Collected Since Sundberg's Series of 215 in 1919

Case No	Sex	Age	Occupation	Duration of illness previous to adm	History and pre operative diagnosis	Operative procedure and findings	Result	Autopsy or pathological findings	Bacteriology	Author
1	M	51		3 days	Epigastric pain vomiting fever Profoundly ill 1 yr before had abdominal pain vomiting tarry stool lasting 1 week		Death 1 day	Cirrhosis of liver associated with diffuse phlegmonous gastritis	Hemolytic streptococci	Anderson
2	M	50		2 weeks gastric distress	Diagnosis Carcinomatous pyloric stenosis	Resection	Death 4th day post-op	Bilateral pneumonia No peritonitis Resected specimen showed carcinoma and circumscribed phlegmonous gastritis		Bardy
3	F		Servant	2 days	Acute abdominal symptoms increasing severity Diagnosis acute appendicitis acute pancreatitis or perforated gastric ulcer	Bilioth II resection of $\frac{3}{4}$ of stomach Uneventful convalescence except for light grippe pneumonia during 2d week	Death 1 mo later from ruptured splenic varix	Edema of gastric wall Ruptured varix of splenic vein Exsanguination from abdominal hemorrhage Resected part of stomach—cedema causing thickening of 8-10 cm	No bacteria demonstrable	Bircher (Case No 2) (Case No 1 identical with Sundberg's Case No 36)
4	F		Servant		Admitted to hospital moribund Staphylococemia sepsis, osteomyelitis of tibia		Death	Osteomyelitis of tibia, staphylococemia, abscess of stom wall, purulent thrombosis of coeliac artery	Staphylococci	Bircher Case No 3
5	F		Peasant	Several yrs intermittent gastric distress after heavy labor in fields 1 mo aggravated symptoms	Emaciated woman with palpable kidney and abdominal mass size of hen's egg near umbilicus Free HCl 24 Total HCl 52 Pyloric stenosis in X-ray picture	Ulcer on greater curvature with area of infiltration 5-6 cm in diam, intramuscular tumor at pylorus Bilioth I resection 9-10 cm wide	Recovery	Specimen resected infiltrated lymph-node, leiomyoma, peptic ulcer suppurative gastritis	Not stated	Bircher Case No 4
6	M	Not given Born in 1864		1 mo gastric disturbances	Stomach dilated, left ing hernia Free HCl 57 Total HCl 95 Pyloric stenosis in X-ray picture	Entire pyloric region infiltrated injected and oedematous lymph-nodes enlarged Pylorotomy	Recovery	Specimen resected suppurative gastritis	Not stated	Bircher Case No 5

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No.	Sex	Age	Occupation	Duration of illness	History	Operation	Pathology	Operative recovery	Post-operative	Specimen of	Culture	Remarks
7	F	34		7 days previous tonsillitis for 2 days	1st day in hospital some epigastric pain, 3rd day severe pain vomiting fever continued till 5th day Diagnosis, acute cholecystitis	Operation	Gastrostomy Phlegmonous gastritis of pylorus, 2 inches broad	Operative recovery 12th day saphenous phlebitis 15th day sharp pain in left chest then gradual improvement till 28th day when fatal pulmonary embolism	No autopsy			Brooks and Clinton
8	M	50	Laborer	6 weeks	Pain and nausea 1/2 hr after meals Loss of weight X-ray showed moderate pyloric stenosis 1 day transient fever Operation following day Diagnosis Carcinoma of pylorus		Subtotal gastrectomy Carcinoma of pylorus Billroth II (Polya-Reichel)	Death 1 day post-op	Specimen of resected stomach shows carcinoma of pylorus with phlegmonous gastritis surrounding it Autopsy no metastatic deposits Streptococci in heart blood	Hemolytic streptococci	Bumm R	
9	M	52	Laborer	40 days	Apparently adm shortly before death			Death	Carcinoma of cardia with localized phlegmonous gastritis Sepsis		Businco (autopsy report)	
10	F	50			Erysipelas following operation on lachrymal sac 7 days prev Convalescing Rise in temp malaise shortly before death repeated vomiting pus in vomitus			Death 22 days after operation	No autopsy	Streptococci	Cange and M cheleau	
11	M	50			Epigastric pain and vomiting No fever rigidity or distention			Death less than 48 hrs from onset	Phlegmonous gastritis of entire organ, no peritonitis	Streptococci	Eurich and Phillips	
12	M	58	Laborer		Sudden onset 11 days after oper for double inguinal hernia Symptoms of upper abdominal peritonitis		Laparotomy drained around stomach and to pelvis Phlegmonous gastritis and peritonitis	Death 8 hours after operation, 4 days after onset of symptoms	Phlegmonous gastritis	Streptococci	Fink	
13	F	22			Diffuse peritonitis following perforated gastric ulcer		Laparotomy and drainage for phlegmonous gastritis and purulent peritonitis	Death from purperal sepsis	Phlegmonous gastritis part of a general sepsis		Fahmy	
14	M	65		2 days	Epigastric tumor		Circumscribed phlegmonous gastritis Pylorectomy	Death 24 hrs after operation	Pyloric 2/3ds of stomach involved No ulcer, peritonitis	Pneumococci	Gerster (See test Case IV)	
15	M	20		8 mos				Operative recovery Death 4 wks later from secondary perforation of stom	Not obtained specimen showed phlegmonous gastritis		Guibal	

TABLE II—Continued
 Summary of 48 Cases of Phlegmonous Gastritis Collected Since Sundberg's Series of 215 in 1919

Case No	Sex	Age	Occupation	Duration of illness previous to adm	History and pre-operative diagnosis	Operative procedure and findings	Result	Autopsy or pathological findings	Bacteriology	Author
16	M	43			Alcoholic Epigastric pain vomiting diarrhoea moderate fever		Death in 2 days	Phlegmon of entire stomach No ulcer		Hickel P
17	M	37		Acute illness brief duration		Abscess of stomach wall in pyloric region drained	Death on 3d day	Phlegmonous gastritis Peritonitis		Kister
18	M	55	Metal polisher	12 wks dull abdominal pain	Free HCl O 4th day slight jaundice gradually declined Few days before death Deuninger's symptom noted		Death 49 days after adm	Diffuse phlegmonous gastritis associated with cholelithiasis	Streptococci	Lawrence J S (Case No 1)
19	M	52	Laborer	3 mos gastric disturbances	Gastric analysis normal except for stasis Pre operative diagnosis Gastric carcinoma	Ulcer of lesser curvature Billroth II Pt did well for 4 days, then worse	Death 7 days after operation	Post-operative phlegmonous gastritis diffuse peritonitis	Streptococci	(Case No 2)
20	M	63	Laborer	6 days sore throat	Chill incessant vomiting epigastric pain fever peritonitis	Laparotomy Stomach covered with fibrin Drainage	Death in 2 1/2 hrs	Phlegmonous gastritis, 2/3ds stomach involved, wall 1 inch thick Fibrinous peritonitis	Streptococci in stained sections	Lehnhoff
21	M	17			Suddenly ill a few hours after eating pork Collapse Epigastric pain vomiting		Death 38 hrs from onset	Typical phlegmonous gastritis, no lesion of mucosa		Moynihan
22	F	60		1 day	Sudden onset intense abdominal pain and vomiting Diagnosis lay between perforated ulcer pancreatitis and acute cholecystitis	Diffuse phlegmon of entire stomach No peritonitis	Death 4th day from onset of symptoms	Diffus phlegmonous gastritis, diffuse peritonitis	Streptococci brevis	MacAuley
23	F	19		3 yrs gastric disturbances worse last 6 mos sudden onset 2 days	Diagnosis cholecystitis Operation 7 days after acute onset	Resection Billroth II Balfour-Polya	Recovery	Large submucous abscess of pyloric region overlying mucosa intact	No report	Novak

PHILEGMONOUS GASTRITIS

24	M	29		4 yrs gastric symptoms	1919 gastro-entrostomy for duodenal ulcer, 1921 jejunostomy for gastrojejunal ulcer with dense adhesions 1922 subtotal gastric resection for gastrojejunal ulcer	Bilroth II	Death on 5th day	Post-operative phlegmonous gastritis around anastomosis in submucosa, peritonitis (Eiselsberg clinic)	Orator Case No I
25	F	45		9 mos	Pain, vomiting, marked loss of weight, palpable tumor Free HCl 0 Total acid, 26 X-ray showed defect in antrum Pre-op diagnosis tumor?	Bilroth II for ulcer of lesser curvature nearer pylorus than cardia	Death not stated but is cited as 2d case of post-op phlegmonous gastritis	Resected specimen showed diphtheritic ulcer and phlegmonous gastritis involving all layers (Eiselsberg clinic)	Case No 2
26	M	25		3 weeks prodromal symptoms 1 day acute symptoms	Sudden onset of epigastric pain while lifting a heavy object Adm with typical symptoms of perforated gastric ulcer X-ray showed air under both sides of diaphragm	Free air in peritoneal cavity Phlegmon of anterior surface of body of stomach with perforation at centre Bilroth II subtotal resection	Marked post-op acidosis controlled by glucose and insulin Recovery	Resected specimen small perforated callous ulcer on greater curvature, 19 cm from pylorus, area of phlegmonous gastritis size of saucer around ulcer	Case No 3
27	M	40				Bilroth I for duodenal ulcer	Death on 5th day from gastric retention	Suture line intact Stomach dilated No peritonitis Microscopically, phlegmonous gastritis around anastomosis	Case No 4
28	F	60		Long history of indigestion	Diagnosis on adm Acute perforated gastric ulcer	Anterior gastro-entrostomy Abdominal drained Phlegmonous gastritis	Death less than 24 h post-op	Phlegmonous gastritis	Owen D R Case No 1 (Autopsy report)
29	M				Diagnosis acute perforated gastric ulcer Profound prostration	Phlegmonous gastritis, diffuse peritonitis Drainage rectovesical pouch Diagnosed as phlegmonous gastritis at operation	Death shortly after operation	Phlegmonous gastritis	Case No 2 (Autopsy report)
30	M		Soldier		In hospital 1 mo., when sudden onset	No operation	Death	Bronchopneumonia Diffuse phlegmonous gastritis (infection of corrosive lesions caused by poison gas)	Pech Case No 1
31	M	39	Soldier			No operation	Death	Pyloric carcinoma with associated circumscribed phlegmonous gastritis	Case No 2
32	F	56		Long history of indigestion	11 days of increased epigastric pain fever leucocytosis	Stomach acutely infected and thickened in pyloric half especially post wall Stomach opened Large ulcer of post wall Bilroth I Duodenum very long	Death 17 days post-op Sloughing Secondary hemorrhage	Resected specimen showed ulcerated carcinoma, suppurative gastritis Apparently no autopsy	Rixford Case No 1

TABLE II—Continued
Summary of 48 Cases of Phlegmonous Gastritis Collected Since Sundberg's Series of 215 in 1910

Case No	Sex	Age	Occupation	Duration of illness previous to adm	History and pre operative diagnosis	Operative procedure and findings	Result	Autopsy or pathological findings	Bacteriology	Author
33	M	54			Alcoholic 1 mo gastric symptoms, worse for past week, much worse past 2 days. Diagnosis acute gastric ulcer with peritonitis	Indurated inflamed area 6 cm in diam Aspiration of this area revealed pus Billroth II resection of pyloric half of stomach	Death 4 hours post-op	Phlegmonous gastritis	Streptococci	Case No 2
34	F	40	Domestic	Sore throat and cold for 6 days	At noon sudden epigastric pain, etc Diagnosis lay between basal pneumonia, acute pancreatitis gastric phlegmon	Entire stomach involved thickened red inert Multiple drains	Death 24 hrs post-op	Phlegmonous gastritis, mucosa intact	Streptococci	Case No 3
35	F	57		2 days	Epigastric pain fever vomiting prostration Diagnosis perforated ulcer	Billroth II resection	Death 2 days after onset	Carcinoma associated with phlegmonous gastritis	Streptococci	Sandelm Case No 1
36	F	44		1 day	Peritonitis of unknown origin		Death 3 days after onset	Phlegmonous gastritis	Streptococci	Case No 2
37	F	44		5 days	Fatal peritonitis of short duration—			Autopsy demonstration Pyloric region mainly involved by typical phlegmonous gastritis	Streptococci	Schoo
38	M	39		7 days	Far gone peritonitis	No operation	Death	Phlegmonous gastritis	Streptococci	Secchi
39	M	29	Colored laborer	1 day	1 mo vague abdominal pains Diagnosis perforated gastric ulcer	Laparotomy with drainage gastrostomy stomach achred thick and boggy	Death 28 hrs after operation	Peritonitis, phlegmonous gastritis, many minute perforations	Streptococci	Shatara
40	F	48		Gastric symptoms for some time 2 days epigastric pain and fever	Pre op diagnosis infected pancreatic cyst	Pain subsided hard epigastric mass felt as abdominal rigidity decreased Operation on 9th day Phlegmonous gastritis with inflammatory thickening of omentum transverse colon mesocolon and gastrocolic ligament	Recovery 5 yrs later entirely well Free HCl = 0 X-ray showed hour-glass contraction on lesser curvature one finger's breadth wide	Aspirated pus from stomach wall showed streptococcus and B subtilis		V Stapelmohr

PHLEGMONOUS GASTRITIS

41	F	40	Of labor- ing class	8 days dys- phagia 2 days ago sudden onset	Epigastric pain repeated vomiting vomitus bloody, fever Diagnosis perito- nitis	Emergency operation Phlegmonous gastritis and peritonitis tampon- nade	Death 9 hrs post-op	Phlegmons of oesophagus, stomach pyloric half, dif- fuse purulent peritonitis	Stohr Case No 1
42	F	74	Of labor- ing class (insane)	3 days	2 days after adm sudden onset of peritonitis	Diffuse peritonitis Phlegmonous gastritis Billroth II resection of pyloric $\frac{2}{3}$ ds	Death 2 days post-op	Pentontis Suture lines in- tact Resected specimen showed phlegmonous gas- tritis in pyloric end at cen- ter of maximal induration was a needle penetrating stomach wall	Case No 2
43	M	51	Sailor	2 days	Alcoholic Acute onset epi- gastric pain tenderness and vomiting Diagnosis ulcer or pancreatitis	Gastrostomy, condition reognized at opera- tion	Death 3d day post-op	Phlegmonous gastritis of py- loric region, peritonitis	Westbrook
44	M	34		6 days	Gastric disturbance as child and again of late Sudden onset epigastric pain nau- sea no vomiting Phys exam negative except for epigastric rigidity and ten- derness No fever Pulse 64 Diagnosis slowly per- forating gastric ulcer	Immediate operation, small abscess sur- rounded by inflamed omentum Tumor on greater curvature size of small apple Billroth II Kronlein- Mikulicz resection with drainage	Recovery	Resected specimen tumor projected into gastric lumen like a hemisphere covered by intact mucous mem- brane On section showed necrotic tissue infiltrated with hemorrhages	Zoepffel
45	M	52	Carpenter	5 days	Erysipelas 5 weeks before admission Moribund	No operation	Death 2 hrs af- ter adm	Entire stomach involved by phlegmon Small ulcer at greater curvature 5 cm from pylorus Scrous peri- tonitis	See text Case I
46	F	27		6 days	Headache chills vomiting no pain in abdomen 4 days after adm transferred to surgical side	Operation (Dr A V M) phlegmonous gastritis of pyloric half of stomach Gastro-enter- ostomy	Death 20 hrs after operation	Phlegmonous gastritis, py- loric ulcer, abscess of gas- tric wall near ulcer	See text Case II
47	M	48		6 days	Frontal headache 4 days ago epigastric pain, some vomiting, fever Moribund on adm signs of pulmo- nary cedema and perito- nitis		Death 3 hrs af- ter adm	Phlegmonous gastritis of en- tire stomach old ulcer at pylorus, healed duodenal ulcer	See text Case III 3
48	F	40		2 days	Chills fever vomiting, epi- gastric pain Provisional diagnosis, pancreatitis Ab- dominal puncture showed streptococci Pancreatitis excluded (Neuhof)		Death 2 days af- ter adm	Phlegmonous gastritis of en- tire stomach involving be- ginning of duodenum No ulcer	See text Case V 5

Present illness began two days before admission when the patient suffered from diffuse abdominal cramps, localized more to the right half of the abdomen. He had vomited several times, there had been no bowel movement for the past two days.

Physical examination on admission showed an old man, acutely ill. The abdomen was tense and rigid, the tenderness being most marked in the upper abdomen. Rebound tenderness throughout. Pre-operative diagnosis was diffuse peritonitis, probably appendicitis or perforated gastric ulcer.

At operation (the author) on May 15, at 1250 A.M., revealed a diffuse purulent peritonitis with a sparse amount of greenish purulent exudate in all parts of the abdominal cavity. The pyloric portion of the stomach was markedly injected and thickened, in contrast to the duodenum and upper part of the body of the stomach. There were flakes of fibrin along the lesser curvature. All lymph-nodes in the abdomen were enlarged. No fat necrosis was present. The rest of the abdominal organs—gall-bladder, appendix, large intestine, etc.—were negative. The pancreas was inspected through unchanged lesser omentum. Drainage was instituted, and the wound closed. Diagnosis: Phlegmonous gastritis with general peritonitis. The patient did not react well, and died twenty-four hours later.

Cultures showed pneumococcus.

Autopsy No 2891. Acute phlegmonous gastritis. Fibrino-purulent peritonitis. Pyloric two-thirds of stomach involved, wall 2 cm thick, due to swelling of mucosa and submucosa. In antrum there were two large necrotic patches of mucosa, 3 to 4 cm square. No ulcers. Duodenum and oesophagus normal.

Microscopical examination. Throughout entire wall of greatly thickened stomach there was tremendous oedema and purulent infiltration. Great number of veins filled with blood-platelet thrombi. Gram-Weigert stain showed cocci throughout section, mainly lanceolate in shape.

CASE V—*Phlegmonous Gastritis*—Susie J., obese negress, forty years, admitted to Mount Sinai Hospital (service of Dr C A Elsberg), February 11, 1923, with history of generalized abdominal pain, vomiting, fever of 104, and chills for the past two days. No antecedent history.

Physical examination on admission showed general abdominal rigidity and tenderness, no masses, no fluid wave. The provisional diagnosis of acute pancreatitis (Dr H Neuhof) was made. At 10 P.M. the same day the blood count was: White cells, 9000, polymorphonuclears, 78 per cent. The next day the patient was delirious and the high fever persisted. Abdominal puncture (Dr Ira Cohen) yielded sero-purulent fluid, in which hæmolytic streptococci were found. The patient died at 145 P.M.

Autopsy No 4191. Phlegmonous gastritis involving the stomach wall from the cardia to the pylorus and the first few centimetres of the duodenum was found, the process being most marked in the antrum. Localized perigastric abscess. No ulcers. Lutetia aortitis.

TABLE I
Surgical Summary of 263 Cases

	Recoveries	Deaths
Exploratory laparotomy with drainage	2	23
Gastrostomy	0	4
Gastro-enterostomy	2	2
Jejunostomy	0	1
Resections	8	10
Drainage of abscess	1	1
Post-operative phlegmonous gastritis	0	5

CONCLUSIONS

1 Phlegmonous gastritis is a rare condition, the varieties and pathogenesis of which are becoming more clearly recognized as material accumulates

2 It may be assumed that there are

a Mild cases in which recovery may occur without the condition being recognized,

b Fulminant types, ending in death within a few hours,

c Acute cases, running a course to two or three weeks, usually with a fatal outcome, but occasionally undergoing spontaneous recovery with more or less protracted convalescence,⁶

d Subacute, chronic forms which may simulate neoplasms, the less extensive types of which may lead to cicatricial changes in the gastric wall, depending on their extent and location

3 Cures reported following palliative surgery, such as local drainage or gastro-enterostomy, may properly be considered as spontaneous recoveries

4 Resection is the operation of choice when feasible. It gives a higher mortality in recent cases than in those which have lasted for some time before reaching the surgeon

5 Post-operative phlegmonous gastritis is probably of more frequent occurrence than is realized, and hence it is advisable to make microscopical examinations of tissues from the region of anastomoses in all cases coming to autopsy

BIBLIOGRAPHY

- Ackermann (1869) Virchow's Arch, vol xlv, p 39
 Anderson (1922) Canadian Med Jour, vol xii, p 492
 Bardy (1910) Finska Lakarsallsk Handl, p 579
 Bircher (1924) Deutsch Ztschr f Chir, vol clxxxvi, p 409
 Brooks and Clinton (1922) J Michigan Med Soc, vol xxi, p 193
 Bumm, R (1925) Deutsch med Wchnschr, vol li, p 434
 Businco (1923) Riforma med, vol xxxix, p 577
 Cange and Michelean (1921) Paris med July 16, p 64
 Cruveilhier (1862) Traite d'anat path generale, Paris, T iv, p 485
 Eurich and Phillips (1921) Lancet, vol i, p 910
 Fahmy, T (1921) Theses de Lausanne
 Fink (1916) Boston Med and Surg J, vol clxxv, p 795
 Galen See Sundbergs Extensive Historical Review
 Gerster (1919) Med Record, New York, vol xcv, p 502
 Guibal, P (1925) Bull et mem soc nat de chir, vol li, p 468
 Hickel, P (1922) Bull et mem soc anat de Paris, No 19, p 257
 Kister (1925) Rev from Russian, cf Zntalbl f Chir, 1925, p 1401
 Lawrence, J S (1926) Boston Med and Surg J, vol cxcv, p 800
 Lehnhoff (1917) J Amer Med Assn, vol lxviii, p 966
 Moynihan (1922) British J of Surg, vol x, p 40
 MacAuley (1922) British J of Surg, vol x, p 40
 Novak (1919) J Amer Med Assn, vol lxxiii, p 1038
 Orator, V (1926) Arch f klin Chir, vol cxl, p 378

⁶ The abscess cases fall in this group

- Owen, D R (1926) Lancet, vol 1, p 865 British Med J, vol 1, p 787
 Pech, H (1922) Theses de Paris, 1923
 Rixford, E (1917) Trans Amer Surg Assn, vol xxxv, p 472
 Sandelin (1922) Finska Lakarsallsk Handl, p 64
 Schoo (1918) Nederl Tijdschr v Geneesk, vol lxi, No 1, p 1600
 Secchi, R (1919) Riforma med, vol xxxv, p 569
 Shatara (1918) J Amer Med Assn, vol lxxi, p 2130
 V Stapelmohr (1925) Wien klin Wchnschr, vol xxxviii, p 1010
 Stieda (1900) Deutsch Ztschr f Chir, vol lvi, p 212
 Stohr (1926) Wiener klin Woch, vol xxxix, p 525
 Sundberg, H (1919) Nord med Archiv, vol li, p 303
 Westbrook, R W (1916) Long Island Med Jour, vol x, p 525
 Zoepffel (1923) Deutsche Zeitschr f Chir, vol clxxxi, p 158

BENIGN HYPERTROPHY OF THE STOMACH AND LINITIS PLASTICA *

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THE question of chronic diffuse thickening of the walls of the stomach has interested pathologists and surgeons for many years

There is a considerable literature on the subject, but owing to the inherent difficulties in the way of an exact pathological diagnosis in these cases and the rarity of their occurrence, there has been, and to a certain extent still is, a decided divergence of opinion as to their classification and as to the interpretation of their pathology. A number of terms have been used to designate the same condition, and to make the confusion worse a number of essentially different pathological processes, on account of their superficial similarity, have been given the same name and treated as one disease.

This diffuse induration or hypertrophy—diffuse to differentiate it from the local induration of benign or malignant ulcer—may be general or confined to a portion of the stomach. If the former, it may be accompanied by a great diminution in the size of the organ, and the condition generally known as leather bottle stomach or linitis plastica is present.

In former days this was usually discovered unexpectedly by the surgeon on opening the abdomen or more frequently by the pathologist in the course of an autopsy. Now it should be recognized by the roentgenologist. The more local type, however, which may or may not be an earlier stage of the general type, still presents difficulties in diagnosis even with the help of the Röntgen-ray.

To begin with it is most often seen in the pyloric portion of the stomach where carcinoma is so frequently found. The symptoms correspond to those of carcinoma or indurated peptic ulcer. Finally the X-ray, upon which we have come to depend so largely for the diagnosis of stomach conditions, does not seem able to differentiate the various pathological conditions, which may be found here, into their true classifications.

The following two cases, which were operated upon by me at the Roosevelt Hospital, both came to the operating table with the diagnosis of carcinoma of the pylorus. Immediately upon palpating the stomach it was felt in each case that there was no ordinary carcinoma or ulcer, and in each there was great uncertainty as to the nature of the lesion and doubt as to the proper method of procedure.

CASE I—Male, age twenty-seven years, was admitted to hospital September 9, 1924

Past History—Measles as a child. Pneumonia at eighteen. Denies lues. Wassermann taken at Marine Hospital four years ago, negative. Treated for duodenal ulcer at Long Island College Hospital one year ago. Wassermann taken there also negative.

* Read before the New York Surgical Society, January 26, 1927

Present Illness—Began about two and one-half years ago with belching of gas and eructations of sour fluid. These symptoms became worse and about two years ago he began to have gnawing pains in the epigastrium. These pains had no relation to meals and were not relieved by taking food. The pain became worse and the attacks more frequent and then vomiting began. He was benefited by a course of treatment one year ago, but for the last two months the pain has been bad, and for the last three weeks, though he has eaten little, he has vomited almost daily. Bowels regular. No blood in stools. He feels weak and he has lost ten pounds in the last year and ten pounds the year before last.

Physical examination revealed the abdomen a little sunken, no masses. Liver and spleen not felt. Slight tenderness in epigastrium and a little muscle spasm. Normal temperature. Blood counts normal. Stools negative for blood. Urine negative. Gastric test-meal showed normal amount of free hydrochloric acid and of total acids.

Röntgen-ray examination by Doctor Steiner: "There is an area in the antrum of the stomach, $3\frac{1}{2}$ cm proximal to the sphincter, that is lacking in pliability. There is a small six-hour residue. The plates suggest an organic change in the extreme pyloric end of the stomach. The findings are not those of an ulcer and not typically those of a growth. There may be a band of adhesions lying across the stomach at this point and crossing the defect. The probabilities are that this is an infiltrating type of new growth."



FIG. 1.—Case I. Appearance of stomach before operation, showing the stenosis of the pylorus and the rigidity of its walls.

Operation—September 24, 1924. The stomach was normal in size. There was a pronounced thickening of the stomach wall in the pylorus, a little proximal to its junction with the duodenum. It formed a ring about 3 cm wide around the pylorus and it extended upward toward the cardia (more along the lesser curvature than the greater) for a distance of 15 cm, diminishing in degree as it extended upward. This thickening was regular in outline, smooth and with an elastic hardness. Nothing to suggest the crater of an ulcer could be felt. The pylorus was evidently partially stenosed by the thickened ring. There were a few adhesions between the pylorus and adjacent structures. The duodenum was quite adherent to the gall-bladder, which was sharply angulated by the adhesion, but otherwise normal. There was no induration along the lesser or greater curvatures and there were no enlarged lymph-nodes and no nodules in the liver.

A partial gastrectomy was done, excising about 10 cm of the stomach. It was not possible to get entirely beyond the indurated area and the line of resection showed the thickened stomach wall, white and moist looking. The mucous membrane did not prolapse as usual over the cut edge of the stomach and in making the anastomosis it was necessary to use care to pick up enough mucosa in the suture. The stump of the duodenum was inverted and a posterior gastro-enterostomy was made, end of stomach to side of jejunum.

Pathological examination by Doctor White. Macroscopic. The specimen consists of a portion of the stomach still preserved in its tube-like shape. The external surface is somewhat congested and no longer glistening, but it is smooth, without elevations or

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puckered contracted portions. The stomach wall is everywhere greatly thickened, hypertrophied and œdematous. This hypertrophy is more pronounced as one approaches the pylorus. It is 5 cm in thickness at the cut fundus and 9 cm just proximal to the pyloric muscle. There is no infiltration of hard or indurated tissue in the wall, it is soft, tough and elastic. The thickening seems to have taken place in the submucosa and muscularis layers. The pyloric canal admits only the little finger, 7 mm in diameter. Here the wall measures 1.4 cm in thickness. On cutting down through the wall in different places of the stomach it is seen to be made up of a mucosa which is thrown into folds and is everywhere soft, œdematous, gray and granular without areas of ulceration or puckering. The remaining portion is soft, brown-red, homogeneous, smooth muscle tissue without infiltrated areas or nodules. On cross-section of the pyloric canal it is seen to be made up of identical architectural structure but with the muscularis layer in greater preponderance. Grossly this specimen reveals no pathology except hypertrophy of the muscularis layer of the stomach with increase toward the pylorus and some œdema of the entire mucosa and wall.

Microscopic—All sections are alike in showing no serous coat and in showing a very thick muscular coat cut obliquely so that no definite division into the layers can be made. The muscle cells are long and of large calibre, stain well in most places and have normal nuclei. A few bundles are pale and somewhat shrivelled, giving the illusion of great proliferation of the sarcolemma cells. There is little or no infiltration of the muscularis, although in the neighborhood of the blood-vessels there are many strands of young connective-tissue cells with deep-staining nuclei. In a few spots are to be seen clumps of pale blue-staining cells with ill-defined cytoplasm, but very deeply stained nuclei. Some of these nuclei are large and vesicular with one or more nucleoli, others resemble connective-tissue nuclei. These cells suggest the sympathetic ganglion cells of Auerbach and Meissner. The submucosa is very œdematous in contrast to other layers and contains dilated blood-vessels, but no abnormal elements. The muscularis mucosa is normal where seen and in these places there is good demarcation between these layers and the proper mucosa. The mucosa shows the lower layers fairly well. The glands are simple branched tubules quite tortuous, their upper body, neck and mouth being often absent. The chief cells are high columnar or pyramidal with normal nuclei and ergostoplasm, but the parietal cells are so heavily stained as to obscure their finer structure. The glands are separated by a richly cellular and vascular stroma which is densely infiltrated with leucocytes. The latter are chiefly lymphocytes and seem to migrate up from the extensive solitary lymph follicles which are seen between the gland fundi and the muscularis mucosa. The lumen of the glands contains blue-staining mucus. The great vascularity and infiltration of mucosa, taken with œdema of submucosa and thickening of the muscular coat point to a long-standing irritative process.

This patient has been followed up carefully. He was last seen about three weeks ago, January 6, 1927, more than two years after his operation.

He is now as he says in perfect health. He eats and drinks as he pleases and has no gastric symptoms. He has regained his normal weight. The following X-ray report



FIG 2—Case I. Two years after partial gastrectomy. The stoma is freely patent. There has been no extension of the disease.

shows the present appearance of his stomach. It is interesting to note that there has been no extension of the pathological process.

"The stomach shows the characteristic deformity of resection with a freely patent stoma. The stomach is completely evacuated at six hours. The remaining segment of the stomach shows good pliability with no evidence of extending induration or recurrence."

CASE II—Male, age thirty-two years. Admitted July 30, 1926. Chief complaint. Gnawing pain in the stomach and loss of weight. Present illness. About ten months ago the man first began to have a gnawing pain in the epigastrium radiating to the back and both sides. This was accompanied by nausea and vomiting of sour material and it usually came on about ten minutes to one hour after meals, though there seemed to be no definite regularity in this respect. He consulted his local doctor, who placed him on a diet free of fried foods and gave him soda. The soda gave relief from pain. He didn't try food for relief of pain. He continued to have the gnawing pain, nausea and vomiting for about one month and a half, when he again regained his appetite and the pain ceased until about four months ago, when the symptoms all returned as before. He has been constipated during the present illness and this condition has been relieved only by large doses of milk of magnesia and cathartics. At times he has noticed that his stools were black in color. He has lost forty pounds in weight during the past year.

Past History—Usual diseases of childhood. No other diseases of any moment. No injuries. No operations. No venereal diseases. After returning from the war the patient was extremely nervous and it took him some time to adapt himself to civilian life. No history of familial diseases.

A fairly well-nourished young man, abdomen flat and soft. No tenderness or muscular spasm. No masses. Kidneys, liver and spleen not felt.

Cervical glands are palpable, but not much enlarged.

Gastric Test Meal—No free hydrochloric acid. Total acidity varying from 10 to 40 in different tests. Blood Wassermann—four plus.

Rontgenological examination by Doctor Steiner. "Annular defect in the extreme pyloric end of the stomach in the immediate prepyloric area. This deformity has all the characteristics of a new growth, at the present time non-obstructive in character."

Operation—August 14, 1926.

The stomach was diminished in size in the pyloric region. The blood-vessels on the anterior and posterior walls were closer together than usual and appeared somewhat enlarged.

The stomach was free anteriorly, but posteriorly it was slightly adherent to the transverse mesocolon.

The pylorus was greatly thickened, both the anterior and posterior walls, more marked on the posterior wall and more marked at the lesser curvature. The thickness of the wall at this point was about one centimetre. The thickening was smooth and even. It did not suggest a new growth. No crater was felt. On incision the cut edge looked white and oedematous.

The induration stopped abruptly at the pyloric ring, but extended to the left for some distance into the body of the stomach, the thickness of the stomach wall gradually decreasing to normal in the cardiac end of the stomach. There was a large superficial ulcer, about 6 cm. in diameter and involving only the mucous membrane, situated at the lesser curvature of the pylorus and extending down the anterior and posterior walls. There were also several punctate erosions of the mucous membrane proximal to it. The mucous membrane was thin, friable, and adherent to the submucosa. It was not thrown up into ridges and folds, as is normally the case, but lay perfectly flat. In making the anastomosis it had a tendency to retract instead of prolapse.

There were a number of enlarged lymph-nodes along the greater and lesser curvature.

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These had the feel of hyperplasia and not of carcinoma. There were no nodules in the liver.

A partial gastrectomy was done with posterior Polya. The induration extended so far toward the cardia that it was not possible to resect all of it, so the anastomosis was through pathological tissue.

Pathological examination by Doctor Lester

Macroscopic—The specimen consists of the distal portion of the stomach. It measures 9 cm by 6 cm. The wall is thickened, measuring 1 cm at the lesser curvature. On the lesser curvature is a shallow irregular ulcer measuring 4 cm by 2 cm. The submucosa is very much thickened and oedematous. The muscularis is also increased in thickness.

Microscopic—Sections were taken through the shallow ulcer and through the underlying musculature. The mucosa of the base of the ulcer is present, but thinned out. The surface is somewhat eroded and lying just underneath it is a considerable round-cell infiltration with a scattering of polymorphonuclear leucocytes, mostly eosinophiles and some red blood-cells. In the deeper layers of the mucosa the inflammatory infiltration is still present, but to a less degree. There are many small blood-vessels throughout the mucosa which are dilated and engorged with blood. The gastric glands, though somewhat distorted by the inflammatory process, maintain their normal arrangement for the most part. The epithelial cells are normal and show no tendency toward hyperplasia, nor invasion.



FIG 3—Case I. The pyloric portion of the stomach split along the greater curvature and spread out flat. Showing the thickness of the walls and the appearance of the mucous membrane. The duodenal junction is on the left.

In the mucosa adjacent to its ulcer the picture is essentially the same, except that the surface is not eroded and the glands are longer. In the deeper layer there is considerable oedema. A few solitary lymph follicles are present. In the submucosa the oedema present in the deeper layers of the mucosa is much more marked. Below the ulcer the oedema is so great that fixed tissue elements are difficult to determine. In the tissue adjacent to the ulcer the oedema is likewise a prominent feature, but the fixed tissue elements are more in evidence though broken up into narrow strands by the oedema. Many capillaries and arterioles are present and distended with blood. A diffuse round-cell infiltration pervades the whole submucosa with dense collections around the arterioles. Red blood-cells are also present outside the vessels. In the muscularis the same inflammatory process exists with oedema and round-cell infiltration. Here, however, it is less acute and there is a moderate amount of fibrosis separating the musculature into bundles. Nerve fibres are abundant and in a few areas, near the serosa, ganglion cells are present. There are no atypical cells. The picture is essentially that of inflammation—subacute on the mucosal surface and shading into chronic in the deeper layers. This causes a definite thickening of the stomach wall which is further increased by hyperplasia of the tissues. There is nothing in it to suggest malignancy.

This man was last seen in December, 1926, about six months after the operation. He was then feeling perfectly well. The roentgenological report is as follows:

"There is a freely patent stomach with the meal, passing freely from the stomach into the jejunum, and we can find no morphological defect in the remaining segment of the stomach. The stomach is completely evacuated at six hours."

Fifteen or twenty years ago both of these stomachs, of different pathology as you have seen, might have been called examples of linitis plastica in an

early stage Many cases are recorded in the literature in which the pathology was very similar The process was usually complete throughout the whole stomach, but nevertheless it was recognized that the disease began in the pylorus as a rule, and was most marked in that region In fact, almost any chronic diffuse thickening of the stomach wall was called *linitis plastica* unless it was a very evident *scirrhous carcinoma*

In an excellent article by Brissaud in 1900 is given a classification of the various processes that were thought by different writers to be *linitis* New growth Chronic inflammation Sclerosis Chronic oedema

He describes the condition as follows

"The wall of the stomach is thickened markedly The thickening is not limited to the pylorus, it can extend to all parts of the stomach It is not a serous or fibrinous infiltration, but the formation of a tissue not preexisting in the stomach A rare disease with a confused symptomatology, not cancerous It begins in the pylorus and spreads through the stomach There are epithelioid cells in the muscularis mucosa and submucosa"

Bensaude and Rivet give *linitis* as one of the forms that syphilis of the stomach may take

Quenu thought *linitis* was probably malignant, but cited two other possibilities *scirrhosis*, primary or secondary, and chronic inflammation

Wyand classified the stomachs as either diffuse carcinoma or diffuse fibromatosis

This confusion caused Goldschmidt to complain that *linitis* was a difficult subject to study from the literature as different authors approached it from the different angles of clinical course, gross pathology or microscopic study, and included carcinoma, lues, gastritis phlegmonosa, fibromatosis, etc

He thinks that a sharp line should be drawn between those cases that are localized in the pylorus and those in which the entire stomach is involved and says that it is especially important to omit those cases which are hypertrophies of the pyloric musculature

In this last contention he is undoubtedly right He is probably wrong in excluding all cases where the main lesion is in the pylorus, for *linitis* is supposed to begin in the pylorus, and though the onset of the disease is so insidious that nearly all the cases reported have been full blown at the time of their discovery yet there are a few cases in which the typical appearance described by Brinton is seen in a lesion confined to the pylorus

One was a case of Quenu's (1906) which, except for the microscopic picture, is very much like the second one of my cases The wall of the stomach in the pyloric region was very thick, $1\frac{1}{2}$ to 2 cm limited abruptly at the duodenal line, but shading off toward the cardia, there was a shallow ulcer In his case the microscopic picture was one of fibrous degeneration and groups of epithelial cells Metastases in the lymph-nodes He did a partial gastrectomy, but the patient died a year later with local recurrence

Monprofit, in discussing Quenu's case, said that he had had a similar one in which the microscopic examination did not show any evidences of cancer, but nevertheless the patient died a year later of a recurrence

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There are some to-day who do not consider linitis a pathological entity. Pauchet, writing in 1924, says that it is nearly always a fibro-carcinoma, but that there are cases which are purely inflammatory, and he considers that the most frequent cause of the inflammatory type is syphilis. But he considers that syphilis of the stomach is much more common than it is supposed to be, while Hartwell thinks that most of the cases reported are not syphilis.

Faroy thinks that syphilis is the cause of the peculiar action and appearance of carcinoma in Brinton's disease.

Lewald recognizes three kinds or causes of linitis: Syphilis, carcinoma or fibromatosis, and counsels pathologists to keep in mind the triple possibility of linitis.

Linitis plastica is a name that was given by Brinton in 1854 to a rare and curious condition of the stomach. This condition or something like it had previously been seen and reported by several writers, notably Cruveilhier and Andral, but Brinton was the first to accurately describe it and give it a clinical entity. He described it, but did not know its nature. He thought it was a benign process, but was not sure. As Brissaud said of the name, "It had the merit of designating the lesion without pretending to explain its nature."



FIG. 4.—Case I. Photomicrograph showing the inflammatory reaction in the mucous membrane, the narrow and oedematous submucosa and part of the muscularis.

This condition was a diffuse or circumscribed increase in the connective tissue of the stomach, chiefly in the submucosa, with a resulting marked thickening in the walls of the stomach and a decrease in its capacity.

This thickening started in the pylorus and gradually extended toward the cardia, progressing faster along the lesser curvature than along the greater. It did not extend down into the duodenum, but ended abruptly at the gastroduodenal junction. Microscopically there was a great increase in the connective tissue of the gastric wall, particularly in the submucosa. The mucous membrane was intact, but at the bottom the gland crypts were surrounded by connective tissue. The muscularis mucosa was not much changed. The greatest change lay in the submucosa. It was enormously thickened by the great increase in fibrous tissue, which lay in irregular bundles and which, together with the interlacing arterioles (the seat of a marked endarteritis) penetrating into the mucosa, gave the peculiar woven effect which suggested

to Brinton the name "limitis" ("rete ex lino facta") Also, in the submucosa, interspersed in this fibrous tissue, were small atypical epithelioid cells, with deep-staining nuclei, lying either singly or in small groups

The muscularis was increased in thickness, but the amount of actual muscle tissue might be decreased by atrophy, connective tissue being found lying between the bundles of muscle cells The muscle cells were not destroyed or invaded The connective-tissue bundles passed into the subserous coat and



FIG 5—Case I Photomicrograph showing the hypertrophy of the muscularis

caused the woven or knitted appearance that the stomach might have from the outside And finally adhesions might be caused between the stomach and adjacent viscera

The disease had an insidious onset, caused great cachexia, and it ended in death

It was not long before pathologists arose who considered the disease cancerous It occurred in people of the cancer age, males more than females Gastric test-meals showed diminution or absence of hydrochloric acid Robitansky, in 1859, was the first to espouse the cause of malignancy He thought that those epithelioid cells in the submucosa were carcinoma cells Others disagreed with him and maintained that they were endothelial cells or at most epithelial cells which had been split off from the gland crypts by the

overgrowth of fibrous tissue Thus was started a discussion which has lasted with varying fortune until the present day

At first opinion was almost entirely in favor of the benign theory and at the beginning of the present century limitis was differentiated quite sharply from the leather bottle stomach, as the following quotations will show

Mayo-Robson, in *Keen's Surgery*, published in 1911, calls leather bottle stomach an atrophic carcinomatous stomach and says "this condition may be simulated by cirrhosis of the stomach (gastric limitis)"—and again—"In true plastic limitis there is no evidence of new growth, the thickening being due to hypertrophy of the muscular coat and infiltration of the wall of the stomach with inflammatory exudate, which in places has been converted into fibrous tissue"

But from about 1905 on, beginning in France, the general opinion began to lean more and more toward the theory of malignancy

Lyle, in 1911, published a most comprehensive article on the subject, in

which he reviewed all the literature and abstracted and analyzed all the reported cases. He considered that 68 of them were benign and 58 malignant. He added a case of his own on which he did a gastro-enterostomy. The examination of a small piece of tissue taken from the stomach for analysis showed that it was benign. This patient lived for eleven years after the operation.

Lyle proved that there was such a condition as a benign diffuse fibrous thickening of the stomach wall with contraction in its size, and he considered that the name *linitis plastica* should be reserved for these cases and the malignant cases discarded.

In the meanwhile the cases reported in the literature grow more and more malignant. This effect was given in some cases by the assertion of the authors that they saw cancer cells in the submucosa (when the nature of those cells was the very subject in dispute) without describing them or giving any other proof of malignancy. Others diagnosed in obvious cases of diffuse carcinoma, with cancer infiltrating all the coats of the stomach, extending into the greater and lesser omenta and with metastases in the lymph-nodes and other organs, until the terms *leather bottle stomach* and *linitis plastica* became synonymous to some writers.

Massias and Auriat, writing in 1922, found that the great majority of writers considered *linitis* to be a malignant neoplasm, and that seems to be the general opinion to-day. There have been great difficulties in the way of settling this question. In the first place, as many writers, Goldschmidt and Lyle particularly, have pointed out, there have been many cases reported as *linitis*, which evidently were not. These were cases of almost pure muscular hypertrophy, of chronic inflammation and of just plain scar tissue following ulcers or other forms of infection, cases of ordinary carcinoma of the scirrhus type, such as have been mentioned above.

As Ewing says, the usual form of scirrhus carcinoma is easily differentiated by the diffuse thickening of all the coats, the frequent presence of metastases and especially by the microscopical evidence of round-cell, or alveolar or gelatinous carcinoma. In *linitis* the epithelioid cells are reduced to a minimum or largely disappear.

"If you wish to converse with me," said Voltaire, "define your terms."

It seems to the present writer that it is useless to try to reverse the present trend in definition, even if it were desirable to do so. Since the time of Brinton pathologists have used the microscopic picture of the disease, with emphasis on the atypical epithelioid cells in the submucosa, as the basis for their discussions.

Quoting Ewing again, "A diffuse scanty infiltration of large cells, with hyperchromatic nuclei, but of wholly indefinite origin."

So let us follow their example and define *linitis plastica*, whether complete or partial in the terms of its microscopic pathology. But even with false and doubtful cases excluded by careful and competent microscopic examination, a decision as to the malignancy of the disease would still have been difficult.

In the description of the course of the disease given some pages back, you will have noticed that its onset was insidious and that it ended in death. Most of the specimens were found at autopsy, and few cases survived after operative interference for more than a year. But the cause of death was not by metastasis as in other forms of malignancy, but by the local effect of the disease on the stomach and consequent starvation, and many of the autopsy specimens showed no metastases whatever.

In case of dispute one cannot prove that a piece of tissue found at autopsy is benign, neither in the absence of metastases can it be proved malignant.

It takes years of survival on the one hand, or the demonstration of metastases on the other, to constitute proof. In a few exceptional cases this proof was forthcoming—but on both sides.

Specimens have been found which showed typical linitis plastica in the stomach and metastases in the adjacent lymph-nodes, with the cells in the nodes similar to those in the stomach and the corresponding tendency toward the formation of fibrous tissue. There have been metastases in other organs as well.

On the other hand, Von Eiselsberg had a patient who lived for fifteen years after a jejunostomy. She died of cancer of the uterus.




FIG. 6—Case II. Appearance of stomach before operation showing rigidity and filling defect in pyloric region.

There is Lyle's case, referred to above, who lived eleven years after a gastro-enterostomy and there are a few others.

The only conclusion that we can draw from this conflict of evidence is that either—

- 1 Linitis is not a pathological entity
- 2 The microscopic picture of none of the surviving cases was that of a typical linitis
- 3 The malignancy may be very low in some cases, so that death by metastasis takes a very long time if the nutrition of the patient is kept up
- 4 Or the tumor may strangle itself in its own fibrous tissue

As Ewing describes it, linitis "is a peculiar form of carcinoma, probably occurring in resistant subjects and originating from cells of limited growth capacity, it pursues a chronic course and tends to spontaneous regression of the tumor process, but to the death of the patient." Ewing bases his opinion that linitis is a form of carcinoma on the fact that on careful examination of a specimen, on hunting long enough, he has always been able to find the cells with mucous degeneration and signet ring nuclei, typical of gastric cancer.

Thus defined and disregarding its interpretation, linitis plastica stands as a sort of no-man's land between the obviously malignant and the plainly benign cases of hypertrophy or induration of the stomach wall

As to the last type, the plainly benign, what can be said as to their etiology? All the suggestions, with the one exception of malignancy, that in the past have been given to account for linitis, can be used here. Idiopathic hypertrophy of the muscle, especially in the pylorus, syphilis, chronic pyogenic inflammation, cirrhosis, fibromatosis, acute phlegmonous gastritis, chronic œdema etc, etc

All of these, it may be, can cause indurations of the stomach wall to be differentiated from Brinton's disease and from one another only by careful microscopical examination

Auneau and Tassin reported cases of hypertrophic stenosis of the pylorus in the aged. Marei-Landerei reported 22 cases of hypertrophic stenosis in adults between the ages of twelve and eighty years with the average age twenty-seven years. It is interesting to note that Cruveilhier, one of the very first to call attention to this condition, called it a benign hypertrophy of the pylorus.

Wyands considers his benign cases to be examples of fibromatosis. Osler recognized a diffuse cirrhosis

of the stomach due to a long-standing catarrh. Stapleholm and Notlmagel both thought that a chronic induration might result in those cases of acute phlegmonous gastritis that survive the acute stage. Pauchet, Faioy, and Bensaude and Rivet thought that syphilis was an important etiological factor. Krompecher thought that the non-malignant cases were due to a chronic inflammation and he attributed the changes in the stomach to œdema, fibrosis, muscular hypertrophy and irritation by foreign bodies.

Ewing says that a considerable group of cases reported in the literature as linitis appear to be examples of chronic gastritis with marked contraction and thickening of the whole or much of the stomach. "In these cases there appears to be a hypertrophy chiefly of the muscular coat, while the submucosa lacks the extensive overgrowth of linitis."

Under one or another of these categories we must place the two cases presented in this paper. For they do not correspond to the definition of linitis plastica and they are not obviously malignant. Moreover, as Krompecher has said, "the presence of œdema is one of the strongest points in favor of a benign process."

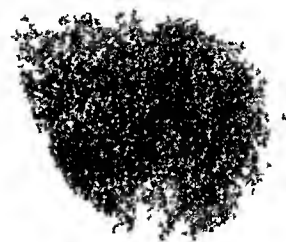


FIG 7—Case II Six months after operation. Stoma freely patent. No extension of disease.

It is my opinion that they are both examples of chronic inflammation of the stomach. The reason for their different microscopic pathology I do not know.

In the first case, of course, with its ring of markedly hypertrophied muscle around the pylorus, the possibility of a hypertrophic stenosis must be considered. In the two cases of Auneau and the one of Tassin there were no signs of a chronic gastritis and there was great proliferation of the sympathetic nerve elements. Auneau considered these to be examples of myomatous hypertrophy, such as is seen in the new-born.

He considered the cases of Chaput and of De Guy, in which a chronic gastritis was present, and those of Hartmann and of Ramond and Clement, in which ulcers were present, to be examples of hypertrophy from irritation. The more so since in the last four cases the hypertrophy showed a tendency to spread over the stomach, while in the first three it was confined to the pylorus.

In the case of Maier-Landerei no microscopical study was made, so it is difficult to draw any conclusions from them. They considered them to be cases of congenital hypertrophy

appearing for the first time in adult life. Krompecher felt that they were wrong in this belief.

In my own case, pain was a prominent feature of the symptomatology. This would seem to indicate that the process was an inflammatory one, as in the hypertrophic stenosis of the new-born pain is absent.

In my second case there is a possibility of syphilis. The patient had a four-plus Wassermann. But as Hartwell so forcefully pointed out, in a paper read before this society in 1925, the presence of a positive Wassermann reaction in a patient with a lesion of the stomach does not prove that it is gastric syphilis. In this case no evidence of syphilis could be found in the slides of the stomach. It is true that syphilis may have been the cause of the inflammation. It is more than likely that the toxins of syphilis had some effect on the course of the disease, just as it has in other inflammatory processes. But that is as much as we can say in the light of our present knowledge.

In considering the operative treatment of cases such as mine, in which the major part of the lesion is in the pyloric half of the stomach, it is important to remember that even with the abdomen open and the stomach between our fingers it is impossible to determine whether the condition is a *limitis plastica* or one of its benign simulacra. A frozen section would be of little



FIG. 8.—Case II. The pyloric portion of the stomach split along the greater curvature and spread out flat. Showing the thickness of the walls, the appearance of the mucosa and the superficial ulcer. The duodenal junction is toward the left.

help Lyons reports that in 25 cases of leather bottle stomach, operated on at the Mayo Clinic, specimens were removed for examination. Six cases, after careful microscopic study, were thought to be benign. All these six patients died shortly after the operation and further microscopic examination of their stomachs showed the presence of the small carcinoma cells in all of them.

In true linitis the best procedure would be a total or subtotal gastrectomy. But considering the insidious onset of that disease the chances are in favor of a benign process in those cases coming to the operating table with only partial involvement of the stomach. And it seems to me that the added risk in doing such radical surgery in the benign cases more than counter-balances the danger of an incomplete operation in the malignant ones.

I consider partial gastrectomy with a Polya anastomosis the operation of choice. In the benign cases it removes most of the disease and the main focus of irritation, and if the pathological process should continue to spread through the remainder of the stomach, there is a wide stoma which can stand considerable contraction without stenosing.

Carnot in his explanation of the symptoms in linitis, says that the pyloric valve may or may not be involved in the thickening and rigidity.

If it is not involved, it remains competent as a sphincter, the stomach wall being diseased and rigid, it does not get its normal stimulus to relax, the stomach itself can hold but a few ounces, consequently food is rejected almost as soon as eaten and the symptoms resemble those of carcinoma of the lower end of the oesophagus.

If, on the other hand, the pyloric valve is involved in the induration, it becomes incontinent. Food entering the stomach can find its way into the duodenum. The symptoms are not nearly so urgent and the patient can live without much discomfort until a stenosis begins to develop.

If after a Polya gastrectomy the induration and contraction should spread through all the rest of the stomach, the second, not the first, condition as described by Carnot would be present, for the stoma is certainly an inconti-



FIG. 9.—Case II. Photomicrograph of the stomach wall showing the floor of the ulcer. There is a good deal of the mucous membrane left and it shows a marked inflammatory reaction. The fibrosis and oedema of the submucosa are quite evident.

nent opening And in addition the rigid gastric canal would be very short, the danger of stenosis would be reduced to a minimum, as it is most likely to occur in the pylorus, and the food entering the stomach could drop by gravity almost directly into the jejunum

SUMMARY

1 As formerly used the term *linitis plastica* designated all the conditions of hypertrophy and induration of the stomach not obviously malignant

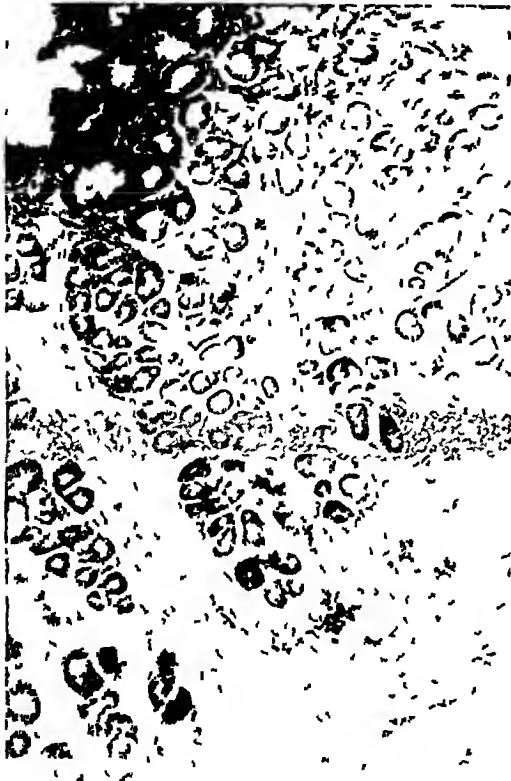


FIG 10 —Case II Photomicrograph of stomach wall adjacent to the ulcer showing inflammatory reaction in the mucous membrane and in the submucosa

2 As now used it refers to a group of cases, probably malignant with a definite micro-pathology, but with a disputed interpretation of that pathology It separates the cases of evident malignancy from those that are clearly benign

3 The benign group can be subdivided into cases of hypertrophic pyloric stenosis, fibromatosis, cirrhosis, chronic inflammation, syphilis, etc, etc

4 The cases reported in this article are probably examples of chronic inflammation

5 All these benign conditions may resemble *linitis plastica* and one another to such a degree that careful microscopical examination is necessary to differentiate them

6 When the lesion is confined to the pyloric half of the stomach the X-ray picture closely resembles that of carcinoma of the pylorus,

and the operation is likely to be undertaken under that diagnosis

7 In this condition it is impossible to tell, at the time of operation, whether one is dealing with a benign or a malignant process

8 In the opinion of the writer a partial gastrectomy with a Polya anastomosis is the operation of choice under these circumstances

BIBLIOGRAPHY

- Achard, Mouzon et Marchal Soc med Hop, Paris, 1923, vol XLVII, p 835
 Auneau These de Paris, 1922
 Anderson Am Jr Med Sc, 1923, vol CLV, p 799
 Babonniere, Brisard et Blum Soc med Hop, Paris, 1922, vol XLVI, p 1135
 Bensaude, Cam et Oury Soc med Hop, Paris, 1923, vol XLVII, p 1510
 Bensaude et Rivet Presse med, 1919, vol XLVII, p 621
 Birck Arch med, belges, 1924, vol LXXVII, p 888

LINITIS PLASTICA

- Brams and Meyer Surg, Gyn and Obs, 1923, vol XXXI, p 127
 Brissaud Sem med, 1900, vol XX, p 415
 Carnot Paris med, 1919, vol IX, p 481
 Chaput Bull Soc med, Paris, 1896
 Chiari Festschrift R Virchow, 1891, vol II, p 279
 Cornil et Pilliet Soc anatomique, February, 1896, p 154
 DeGuy Bull Soc anat, Paris, 1896, vol X, p 314
 Von Eiselsberg Surg, Gyn and Obs, 1908, vol VII, p 254
 Von Eiselsberg Arch f Klin Chir, 1919, vol CXII, p 1030
 Enrequez et Gaston-Durand Soc med Hop, Paris, 1921, vol XLV, p 949
 Ewing Neoplastic Diseases, 1919, p 639
 Faroy Arch mal de l'app digestif, 1924, vol XIV, p 616
 Gibson St Luke's Hosp Med and Surg Report, 1908-1909, p 76
 Goldschmidt Arch f Klin Chir, 1922, vol CXX, p 551
 Graham ANNALS OF SURGERY, 1922, vol LXXVI, p 449
 Harrigan ANNALS OF SURGERY, 1921, vol LXXIII, p 551
 Hartmann Ac de méd, 1914, vol LXXI, p 334
 Hartwell ANNALS OF SURGERY, 1925, vol LXXVI, p 767
 Konjetzny Arch f Klin Chir, 1924, vol CXXIX, p 139
 Krompecher Beitr z Path Anat u z allg Path, 1910, vol XLIV, p 384
 Krompecher und Makai Zeitschrift f Krebsforschung, 1912, vol VI, p 200
 Larimore Surg, Gyn and Obs, 1923, vol XXXVII, p 133
 Le Noir, Richet et Langle Arch de mal de l'app digestif, 1920, vol V, p 513
 Lewald Am Jr of Rontgenol, 1921, vol VIII, p 163
 Lyle ANNALS OF SURGERY, 1911, vol LIV, p 625
 Lyons Surg, Gyn and Obs, 1924, vol XXXIX, p 34
 Maier Virch Arch, 1885, vol CII, p 413
 Massias et Auriat Jr med Bordeaux, 1922, vol XCIV, p 393
 Mayo-Robson Keen's Surgery, 1911, vol III, pp 921 and 957
 Mil'ler Med Clin N America, 1923, vol VI, p 911
 Nield Pract London, 1907, vol LXXVIII, p 650
 Oliver ANNALS OF SURGERY, 1922, vol LXXVI, p 444
 Osler Practice of Medicine, 1902, p 467
 Palmer, Watkins and Mills Surg, Gyn and Obs, 1921, vol XXXIII, p 281
 Pauchet Semana med, 1924, vol I, p 319
 Quenu Soc de Chir, Paris, 1906, vol LXXII, p 731
 Ramond et Clement Soc med des Hop, Paris, 1920, vol XLIV, p 616
 Reid Surg, Gyn and Obs, 1925, vol LI, p 667
 Shaw and Venables Guy's Hosp Rep 1923, vol LXXIII, p 438
 Sherren Choyce and Beattie, System of Surgery, 1911, vol II, pp 314 and 398
 Stapelmohr Deutch med Wochenschrift, 1918, vol XLIV, p 127
 Tassin Bull Soc Anat, Paris, 1904, vol LXXIV, p 352
 Thomson and Graham Edinburgh Med Jr, 1913, p 7
 Wyard Surg, Gyn and Obs, 1925, vol LI, p 449

THE EFFECT ON THE JEJUNAL MUCOSA OF TRANSPLANTATION TO THE LESSER CURVATURE OF THE STOMACH*

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SUFFICIENT evidence has been presented to prove definitely that chemical and mechanical factors are of great importance in the production of certain experimental peptic ulcers and in the prevention of healing (Mann). The character of the lesion and its usual site of formation would suggest that the same factors are significant in the production of peptic ulcer in man although most of the experimental studies were on the jejunal ulcer. One of the most important points of evidence against the view that the chemical factor is of significance in the causation of gastrojejunal ulcer is the fact that ulcer does not form when the jejunal mucosa is transplanted with intact blood supply into the gastric wall. It would seem logical to assume that, if gastric digestion were a factor on the causation of gastrojejunal ulcer, it would occur from such transplantation, but, as a matter of fact jejunal mucosa has remained normal for almost a year after being transplanted into the anterior wall of the stomach (Mann).

The mechanics of the emptying of the stomach are such that it is highly probable that some areas of gastric mucosa are subjected to greater chemical and mechanical stress than others. The importance of this fact in regard to the usual site of ulcer formation in the stomach, the lesser curvature, has been repeatedly emphasized, especially by Aschoff, and has been substantiated experimentally by Morton. Owing probably to the ease of performing the operation, the jejunal transplant has always been placed in the anterior or posterior wall of the stomach, where peptic ulcer rarely occurs. In view of the definite knowledge that chemical and mechanical factors were of such great importance in the production of certain jejunal ulcers, it seemed desirable to repeat the previous work but to select the site where the stress of the chemical and mechanical factors was greater and where peptic ulcer usually occurs in man, the lesser curvature.

A considerable number of observations has been made on gastrojejunal ulcer since the lesion was first observed, many of which are pertinent to the etiology of the lesion. The ulcer is usually situated in the jejunum at the point where the mesentery is attached. It occurs more often after anterior than after posterior gastrojejunostomy, and the lesion is most likely to develop after certain special types of operation, such as the Y method and pyloric

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exclusion, consisting of division of the stomach at the pylorus De Takats reported an incidence of jejunal ulcers as high as 21 per cent after gastroenterostomy with pyloric exclusion Denk reviewed 309 cases of post-operative jejunal ulcer Benign pyloric stenosis occurring with post-operative jejunal ulcer was noted in most of the male patients In this series only two cases were noted in which the original lesion was distant from the pylorus Balfour recently reviewed the problem of gastrojejunal ulcer Although the incidence of gastrojejunal ulcer following gastro-enterostomy is relatively low, it is greater after duodenal than after gastric ulcer De Takats suggests that in the future it may be possible to correlate the incidence of gastrojejunal ulcer with the degree and character of the pyloric obstruction

A complete analysis demonstrates that certain factors are present in all those operations on the stomach that show an increased percentage of jejunal ulcers The most important factor is the prevention of the contents

of the duodenum from meeting and quickly and

completely mixing with the gastric contents as they emerge from the stomach The Y operation particularly has this defect With pyloroplasty, gastroduodenostomy and similar types of operation, the gastric contents impinge on duodenal, not jejunal mucosa, and also it is possible for the contents to mix

Experimental work has largely corroborated the general clinical observations A few jejunal ulcers have been induced by diverting the duodenal contents as in some of the operations performed on man Exalto, Bickel, Koennecke, Dott and Lim and van der Hutten induced gastrojejunal ulcer by performing gastro-enterostomy with pyloric occlusion Mann and Williamson uniformly induced jejunal ulcer by draining the duodenal contents away from the point of emergence of the gastric contents

Although the experiments dealing with diversion of the duodenal contents prove that a chemical factor is of great importance in the production of jejunal ulcer, those dealing with transplantation of jejunal mucosa into the gastric wall have not shown the development of ulcer when the mucosa was directly exposed to the gastric contents Hotz has given a complete bibliography of the early work on intestinal transplants in the stomach The



FIG 1—Transplant of jejunum to the lesser curvature of stomach which remained normal for 233 days

results of these experiments showed that, if the circulation of such transplants was maintained, the jejunal mucosa remained intact. The more recent work of Dragstedt and Vaughn, who transplanted duodenum, jejunum, ileum, colon, incised spleen, and kidney into the anterior wall of the stomach, also showed that digestion or the formation of ulcers in such transplants did not occur if the circulation was maintained.

These experiments in which the jejunum was transplanted into the gastric wall demonstrated that simple exposure to the gastric contents was not the

only factor in the production of jejunal ulcer. It is difficult to distinguish the possible effect the acidity of the gastric contents might exert on the jejunal mucosa at the opening of a gastro-enteric anastomosis from the mechanical effect of the expulsion of such contents from the gastric cavity. The possibility that the usual site of gastric ulcer is due to an anatomic and functional



FIG. 2—Transplant of jejunum to the lesser curvature of the stomach in which an ulcer was found 181 days after operation. The transplant measured 3 by 5 cm. and the ulcer 1.4 by 0.6 cm.

difference in the region of the lesser curvature of the stomach from the rest of the organ has been repeatedly emphasized, and all the observations bearing on the suggestion have recently been reviewed by Aschoff.² While the hypothesis has not been generally accepted in its entirety, the observations concerning it are sufficient to justify its careful consideration. It is thus evident that, if the situation of peptic ulcer in the stomach is at least partially due to a greater mechanical stress at this site and if there is also a mechanical factor in the location of gastrojejunal ulcer in man, the reason for the failure of ulcer to develop in jejunal transplants in the stomach, may be that at the site selected for the transplant the mechanical factor was of little or no significance.

All the experiments were performed on normal healthy dogs. All operative procedures were carried out under ether anesthesia and with aseptic technique. Only absorbable sutures were used and intestinal clamps were not employed. The routine operative technique was as follows. The first loop of the jejunum with mesentery sufficiently long to allow it to reach to the lesser curvature of the stomach was exposed and a portion about 5 cm. long resected with its mesenteric circulation carefully preserved. The jejunal loop was then split longitudinally opposite its mesenteric attachment and trimmed to an approximately circular shape. An area of the gastric wall on the lesser curvature near the pylorus, about the same size as the prepared portion of

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the jejunum, was removed and the latter sutured into this opening as a patch. In most experiments the jejunal patch was brought up over the anterior wall of the stomach but in a few experiments it was brought up over the posterior wall. In all cases the patch was placed saddle-wise over the lesser curvature. Great care was exercised in maintaining the circulation to the jejunal patch intact. The continuity of the intestine was reestablished by end-to-end anastomosis. The animals received the usual post-operative care and diet. They were maintained in excellent condition and most of them seemed normal in every respect. At various intervals laparotomy was performed and the condition of the jejunal patch carefully observed. Finally some of the animals were killed under ether. In these instances it was shown that the transplant had an adequate blood supply because marked hemorrhage always occurred when the vein draining the transplant was severed.



FIG. 3—Section of ulcer found 117 days after operation ($\times 10$)

It was fairly easy to perform the operations. The main technical difficulties were (1) to prevent soiling of the operative field, (2) to maintain an adequate circulation to the transposed jejunum, and (3) to locate the transplant at the desired site. Soiling was prevented by the usual measure of being very careful in packing off the operative field. The circulation to the transplant was assured by selecting a loop of jejunum which had a long mesentery and thus long vessels. The greatest difficulty was experienced not only in locating the transplant definitely on the lesser curvature of the stomach but in preventing it from forming simply a jejunal pouch, similar to a diverticulum. It was found impossible always to place transplant at the desired site.

Transplantation of the jejunum to the region of the lesser curvature of the stomach was successful in twenty-five instances, and a definite ulcer developed in three instances. These were typical peptic ulcers. Careful examination of the transplants in which ulcers developed, either by observing the blood return from the veins draining the transplant or by injecting dye into the artery going to the transplant, demonstrated that the blood supply to the site of ulceration was intact. The transplants in which the ulcers occurred were all located at the desired site on the lesser curvature near the pylorus and formed a definite and contiguous part of the gastric wall with no pouching. The ulcers were situated directly in the line of the lesser curvature. In most of the experiments in which the jejunal mucosa remained normal the transplant not only had not been located definitely over the line of the lesser curvature but it had also become pouched.

The results of the experiments permit two definite statements. When a portion of the jejunum with intact blood supply is transplanted into the lesser curvature of the stomach, the jejunal mucosa usually maintains its normal appearance. In a certain small percentage of instances a typical peptic ulcer forms in the transplanted jejunum. The development of the ulcer is not due to deficient blood supply and apparently does not occur when the jejunum is transplanted to any other region of the stomach.

In spite of the small percentage of instances in which an ulcer developed



FIG. 4—Same section as shown in Fig. 3 taken at the site of transition of jejunal and gastric mucosa ($\times 75$)

in a transplant on the lesser curvature, it would appear to be significant in view of the complete failure of ulcer to develop in transplants in other regions of the stomach. In the study of the various specimens of the transplanted jejunum, the situation of the ulcers and of the transplant in which they occurred at a definite site in the gastric wall appeared suggestive. It is quite possible that ulcer would have occurred in more in-

stances if technically it had been possible to place the transplant always directly over the lesser curvature and to avoid the development of a pouch.

Two interesting observations were made in some of the experiments of this series which may be of some significance in relation to the ulcer problem. In the mucosa of the transplants in which an ulcer developed, there was a marked increase in the goblet cells. In a few instances in the series very few cells other than goblet cells could be found in the mucosa. This observation might be interpreted as the development and possibly failure of the protective elements in the mucosa. In a few animals enormous dilatation of the stomach occurred. In one instance the stomach was so large that it almost filled the distended abdomen. The gastric contents would be retained for three or four days although there was no mechanical obstruction of the gastric outlet. The dilatation occurred in those instances in which the transplant was large and a large pouch had formed (Figs. 1, 2, 3, and 4).

SUMMARY

Transplants of jejunum with intact blood supply, from the region where gastrojejunal ulcer develops following gastro-enterostomy in man, were made into the lesser curvature of the stomach in dogs at the site where gastric ulcer

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usually occurs in man. A typical peptic ulcer developed in the transplant in a small percentage of instances. This fact appears significant as no ulcers developed when the transplant was made elsewhere in the gastric wall. The results of these experiments add more suggestive data on the hypothesis that mechanical stress is an important factor in determining the site of formation of peptic ulcer.

BIBLIOGRAPHY

- ¹ Aschoff, Ludwig. Über die Bedeutung des Isthmus ventriculi für die Lokalisation der Magengeschwüre. *Zentralbl f Chir*, 1920, vol. xlvii, pp. 1449-1450.
- ² Aschoff, Ludwig. The Relation of Mucosal Erosions to the Development of Ulcer of the Stomach. *Lectures on Pathology*, New York, Paul B. Hoeber, 1924.
- ³ Balfour, D. C. The Occurrence and Management of Gastro-jejunal Ulcer. *ANNALS OF SURGERY*, 1926, vol. lxxiv, pp. 271-280.
- ⁴ Bickel, A. Beobachtungen an Hunden mit extirpiertem Duodenum. *Berl klin Wchnschr*, 1909, vol. xli, pp. 1201-1202.
- ⁵ Denk, W. Studien über die Ätiologie und Prophylaxe des post-operativen Jejunalgeschwüres. *Arch f klin Chir*, 1921, vol. cxvi, pp. 1-52.
- ⁶ De Takats, Geza. The Surgery of Gastric and Duodenal Ulcers. *ANNALS OF SURGERY*, 1926, vol. lxxiv, pp. 217-221.
- ⁷ De Takats, Geza. The Perverted Physiology of the Stomach After Gastric Operations. *Am Jour Med Sc*, 1926, vol. clxxii, pp. 45-51.
- ⁸ Dott, N. M., and Lim, R. K. S. Experimental Jejunal Ulcer. *Proc XI Internat Physiol Cong*, Edinburgh, 1923, pp. 23-27.
- ⁹ Dragstedt, L. R., and Vaughn, A. M. Gastric Ulcer Studies. *Arch Surg*, 1924, vol. viii, pp. 791-810.
- ¹⁰ Exalto, Y. Ulcus jejunum nach Gastro-enterostomie. *Mitt a d Grenzgeb d Med u Chir*, 1911, vol. xliii, pp. 13-41.
- ¹¹ Haberer, H. v. Ulcus duodeni und post-operatives peptisches Jejunalgeschwür. *Arch f klin Chir*, 1918, vol. cx, pp. 413-566.
- ¹² Hotz, Gerhard. Versuche über die Selbstverdauung des Darmes im Magen. *Mitt a d Grenzgeb d Med u Chir*, 1910, vol. xli, pp. 143-153.
- ¹³ Hutten, Fritz, v. d. Experimenteller Beitrag zur Ätiologie des Ulcus pepticum jejunum. *Beitr z klin Chir*, 1923-1924, vol. cxix, pp. 20-39.
- ¹⁴ Koennecke, W. Ulkusgenese und Gastro-enterostomie. *Beitr z klin Chir*, 1925, vol. cxlxxv, pp. 118-135.
- ¹⁵ Mann, F. C. The Chemical and Mechanical Factors in Experimentally Produced Peptic Ulcer. *Surg Clin N Amer*, 1925, vol. v, pp. 753-776.
- ¹⁶ Mann, F. C. The Effect on the Jejunal Mucosa of Exposure to the Gastric Juice. *Jour Med Res*, 1917, vol. xxxv, pp. 289-294.
- ¹⁷ Mann, F. C., and Williamson, C. S. The Experimental Production of Peptic Ulcer. *ANNALS OF SURGERY*, 1923, vol. lxxvii, pp. 409-422.
- ¹⁸ Morton, C. B. Observations on Peptic Ulcer. I. A Method of Producing Chronic Gastric Ulcer. A Consideration of the Etiology. *ANNALS OF SURGERY*, 1927, vol. lxxxv, pp. 207-221.

ACUTE DILATATION OF THE STOMACH OCCURRING UNDER GENERAL ANÆSTHESIA

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AN EXPERIMENTAL STUDY

INTRODUCTION —It is not remarkable that a symptom-complex presenting features so dramatic as those seen in acute dilatation of the stomach should occupy an important place in surgical literature. The earlier writers, Fagge,¹ Morris,² and others confined themselves for the most part to concise descriptions of cases which they had observed. More recently, Conner,³ Laffer,⁴ Borchgrevink,⁵ Doolin,⁶ Novak,⁷ Lee⁸ and others have prepared careful analyses and discussions of the cases on record, each writer usually contributing a few cases coming within his own personal experience.

Since the etiology of acute dilatation of the stomach does not rest upon a definite pathological basis, it has been customary to follow Connor's example and group the cases according to the general condition of the patient at the time the dilatation occurred and the circumstances surrounding its onset. The two chief groups are considered to be: First, those cases where the dilatation occurs after surgical procedures, usually abdominal operations, second, those arising as complications during the course of any severe wasting illness. In 1916, Lee⁸ added another group, composed of cases in which the dilatation occurred on the operating table while the patient was under the influence of a general anæsthetic. He collected and discussed six such cases, including one of his own. In 1921, Novak⁷ referred to eleven of these cases previously described and added two, which had come under his own observation. Abstracts of two of them and of one which recently came under my observation are here presented.

W. G. RICHARDSON⁹—*Acute Dilatation of the Stomach occurring in the course of an operation for Duodenal Ulcer.* A man, aged forty-seven, entered with history and physical examination typical of perforated duodenal ulcer. The ulcer had perforated at 9 P. M., October 5, he was operated on at 4 A. M., October 6. The abdomen was opened by a vertical incision through the middle of the right rectus muscle, and a perforated duodenal ulcer was found. The hole in the duodenum was closed with catgut purse-string sutures. The operation was simple and easy. There was trouble in administering the anæsthetic satisfactorily. Anæsthesia was induced with chloroform and kept up with ether, given by the open method, and the patient struggled a good deal during induction. He was of bad color during the operation and the respiration was entirely abdominal. During the closure of the peritoneum it was noticed that the upper part of the abdomen was distended. Less than half a minute later the stomach was bulging into the lower part of the wound, and the distention increased so rapidly that the suture had to be unlaced. A stomach tube was passed by mouth. Immediately there was a rush of gas through the tube and the distention disappeared, the respiration became quiet and wholly thoracic, the complexion became pink, the pupils contracted and the whole aspect of the patient changed. Less than

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five minutes elapsed between the beginning of the distention and the recovery. The patient did well after the operation, there were no complications.

EMIL NOVAK—Woman, aged twenty-nine. Operation: modified Gilliam suspension, and separation of abdominal adhesions. During the course of the operation the stomach suddenly became tremendously dilated, so that it filled the whole upper abdominal cavity and pushed down into the supra-pubic incision. The patient was in the Trendelenburg position, the pulse-rate was only slightly accelerated, and no swallowing movements were observed by the anaesthetist. Within a very short time, certainly less than thirty seconds, the stomach had reached an enormous size. A stomach tube was passed, causing instantaneous collapse of the organ. Within eight or ten minutes the dilatation occurred again, in exactly the same way, and was again relieved by the stomach tube. There was no further recurrence of the distention, either during the operation or during the convalescence, which was uneventful.

M. A. McIVER—White man, aged twenty-three. Operated upon three hours after an acute perforation of a duodenal ulcer. Ether anaesthesia. The abdomen was opened through an upper right rectus incision. The perforation, located in the first part of the duodenum, was infolded. A posterior gastro-enterostomy was decided upon. At about the time that the posterior wall of the stomach was being drawn through the opening in the mesocolon, the stomach suddenly began to dilate, increasing rapidly in size. Coincident with this dilatation, peristaltic sounds could be heard, suggesting the entrance into the stomach of air from the oesophagus. The anaesthetist stated that the patient was not making any swallowing movements, and this was confirmed by palpation of the larynx. Respiration was abdominal in character. The distention was relieved by introducing a hollow needle into the stomach, permitting the gas to escape. The remainder of the operation and the convalescence were uneventful.

It seems as though the grouping made by Lee and Novak, which is represented by these three cases, were characterized by features distinctive enough to warrant its consideration as a definite entity. In each instance the dilatation has complicated an operation not otherwise remarkable, the patients have all been under a general anaesthetic, the dilatation has been due to a rapid accumulation of gas, the majority of the patients have apparently not shown any grave symptoms* in spite of the great distention of the stomach, and in most of the cases immediate and permanent reduction of the dilatation has been obtained by passing a stomach tube and allowing the gas to escape. It is natural to conclude that such cases, coming on suddenly and cured by simple means, belong in a different class from the dilatations of the stomach which complicate various types of serious illness: dilatations where the stomach is distended by large quantities of fluid as well as by gas, and which are attended by grave symptoms, by a comparatively long course, a marked tendency to recurrence, and a high mortality.

Although the group of cases in which the dilatation occurs suddenly under a general anaesthesia is a small one, it is probably not so small as one would judge from the number of cases reported in the literature, for practically all surgeons of experience with whom I have talked on the subject can recall one such case or more coming under their observation. It is an interesting problem to attempt to explain the mechanism of this type of dilatation, and it is not adequate to say, as has often been said, that a paralysis of the

* Lee's⁸ case of acute dilatation was complicated by chronic dilatation of the stomach.

stomach occurs, for the dilatation is an active, not a passive, phenomenon, the gas must be introduced under pressure sufficient to balloon out the walls of the stomach. The work of Kelling¹⁰ is of interest in this connection. This investigator showed that in unanæsthetized dogs with a gastrostomy he could produce only moderate degrees of distention of the stomach by pumping air in through the gastrostomy opening, because a regurgitation through the oesophagus emptied the stomach as soon as the intra-gastric pressure rose.

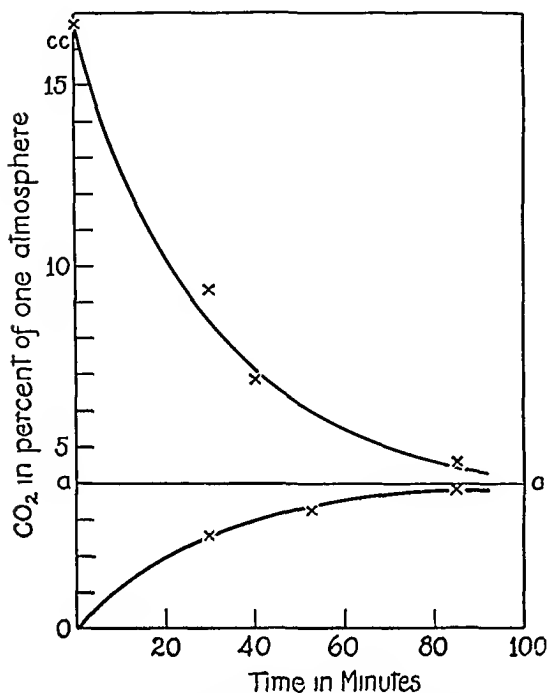


FIG. 1.—When air is injected into the stomach CO enters until the concentration equals that of the blood. The crosses related to the lower curve show the rate at which this proceeds. When air containing a high percentage of CO is injected into the stomach CO₂ diffuses out of the stomach into the blood. The crosses along the upper curve show the rate at which this process goes on. The crosses represent actual measurements. The curves are calculated on the assumption that CO is passing by diffusion and not by secretion. The close agreement between the crosses and the curves suggests that CO enters and leaves the stomach by the process of diffusion. The line a—a represents the concentration of CO in the blood.

If, on the other hand, the dogs were first anæsthetized, an enormous degree of distention could be produced without any escape of air. This has a bearing on the amount of distention that may occur, but presents no evidence as to the origin or mode of entrance of the gas causing dilatation in the type of case under discussion. These latter questions constitute our present problem.

ORIGIN OF GAS CAUSING DILATATION — *Fermentation* — The possibility that gases arising by fermentation play any role in this type of acute dilatation is definitely excluded because of the suddenness of the distention. *Secretion* — The possibility that the gas might be due to a secretion of CO₂ from the blood stream, abnormally increased by circulatory interference, was suggested to Woodyatt and Graham¹¹ by Schierbeck's¹² theory that CO₂ was secreted into the

stomach under normal conditions, and after a series of experiments they concluded that such secretory activity might be responsible, at least in part, for the gas present in acute dilatation of the stomach. In the group of cases now under consideration, however, the rapidity of the dilatation would seem to rule out such a possibility. Furthermore, in studies recently published (McIver, Redfield and Benedict¹³) it was shown that the movement of CO₂ into and out of the stomach proceeds according to the physical laws governing the diffusion of gases and that there is no reason to assume any secretory activity on the part of the gastric mucosa. Fig. 1, taken from the above-mentioned article, illustrates this point: the close agreement between the amounts of CO₂ actually found in the stomach after varying periods of time and the mathematical curves constructed on the assumption that the

ACUTE DILATATION OF THE STOMACH

process is one of diffusion, makes it unlikely that any secretion occurs *Diffusion from the blood stream* The amount of gas entering the stomach by diffusion would obviously be too small to play any important rôle in this type of dilatation *Atmospheric air* Since gases arising by fermentation, by secretion or by diffusion from the blood stream are not responsible for the type of dilatation under discussion, the question narrows itself to a consideration of the mode of entrance of atmospheric air, the remaining source of gas found in the dilated stomach

MODE OF ENTRANCE OF ATMOSPHERIC AIR—It has been pointed out in a recent communication (McIvei, Benedict and Chene¹⁴) that during the stage of ether induction and the period of recovery from etherization, considerable amounts of air are often introduced into the stomach by swallowing, and that this swallowed air plays a rôle in the production of post-operative distention In the cases of acute dilatation now under discussion, however, it is unlikely that air swallowed plays any important part, for most of these dilatations occurred at the end of the operation, when the complex reflex of swallowing would have been abolished by anæsthesia It is also stated by a number of observers that no swallowing movements of the larynx could be noted at the time the dilatation occurred

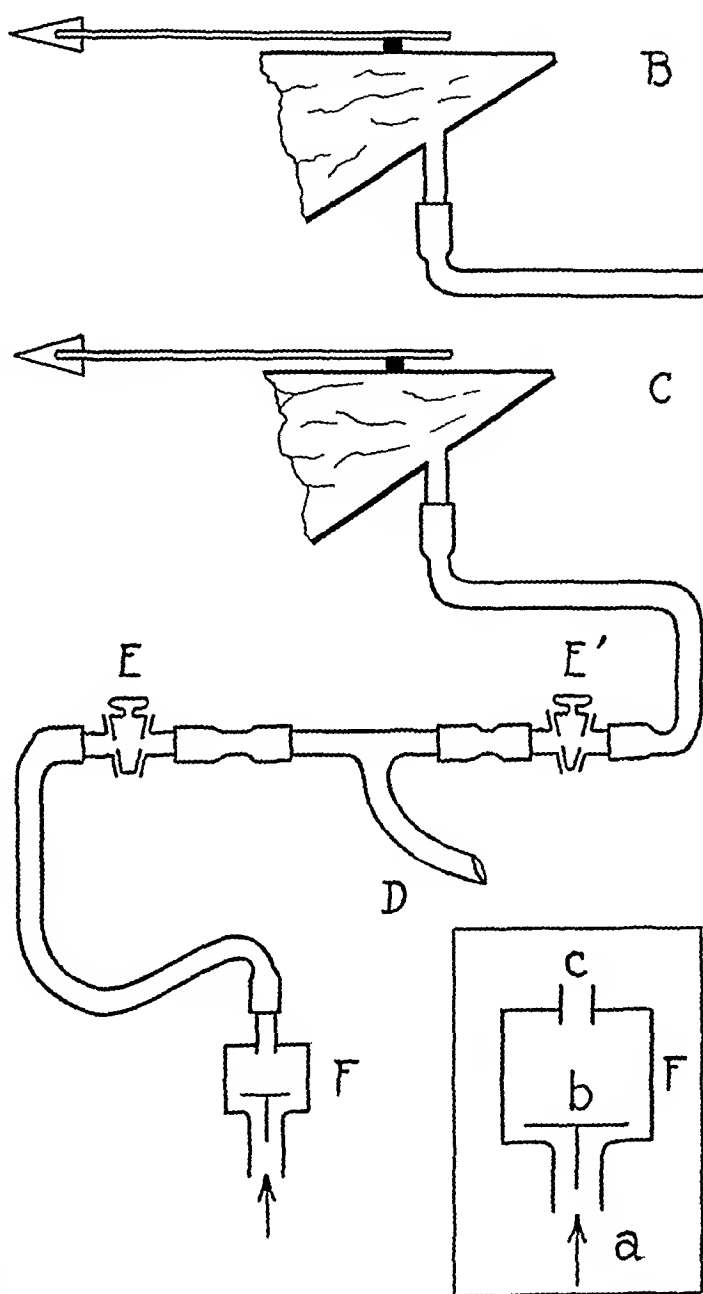


FIG 2.—Diagram of apparatus B Brodie bellows connected with the stomach by means of a rubber tube and hollow needle C Brodie bellows connected with glass T-tube D the stem of which is passed into the upper end of the œsophagus E and E' Stopcocks F Valve permitting the entrance of air but blocking its exit Insert Valve The inlet is at a The exit of air drawn into the chamber is prevented by a circular piece of very thin aluminium covered with delicate rubber dam (b) The exit for the air is at c

The present investigation has sought to determine whether there exists a

mechanism other than swallowing whereby atmospheric air, during anaesthesia, may gain entrance to the stomach under a pressure sufficient to cause dilatation

Two quite possible modes of action present themselves. The first I believe is reasonable, although I have not so far been able to bring it about in animals. The trachea and the oesophagus open into the pharynx. If some obstruction arose which permitted the entrance of air to the pharynx but interfered with its exit, the air issuing from the glottis would greatly raise the intrapharyngeal pressure and might be forced down the oesophagus, causing a dilatation of the stomach.

A clue to the second possible explanation was obtained in the course of an experiment in which a glass tube had been introduced into the upper

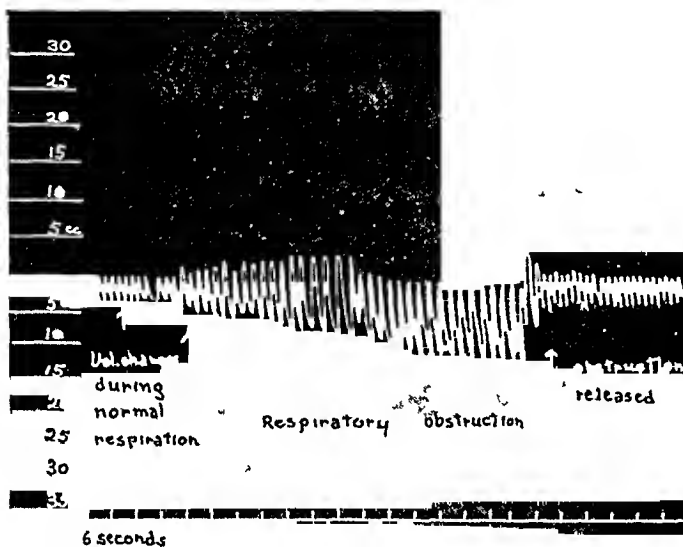


FIG 3—This tracing shows the movement of air into and out of the oesophagus during each respiratory cycle both under normal conditions and during respiratory obstruction. It will be observed that the amount of air drawn in is greatly increased during the phase of labored respiration. The time is shown in six second intervals.

ing in the chest during each respiratory cycle. Under normal conditions, the oesophagus is collapsed, but if a communication with the outside air is established by means of a rigid tube, the negative pressure created in the thorax during inspiration draws air into the oesophagus just as the blood is drawn into the great veins of the thorax from the veins of the abdomen and neck. In our experiment, during quiet respiration only a few c.c. of air passed into and out of the oesophagus, but during strong respiratory effort caused by obstruction to the trachea, the quantity of air taken in was greatly increased (Fig 3). It seemed reasonable to suppose, therefore, that if any valve-like obstruction prevented the escape of the air drawn into the oesophagus, dilatation of the stomach would follow. This idea was tested as described below.

THE METHOD—The experiments were carried out on cats under ether anaesthesia. After anaesthesia had been established, a short midline incision

oesophagus of an anaesthetized animal. During a period of labored respiration, the stomach was observed to dilate, and it was found upon connecting the oesophageal tube with a recording apparatus that a considerable quantity of air passed into and out of the oesophagus at each inspiration and expiration (Fig 3). This phenomenon is due to the fact that the oesophagus, in common with other intra-thoracic viscera, is subject to the pressure changes occurring

ACUTE DILATATION OF THE STOMACH

was made in the neck, and a tracheal cannula inserted. The stem of a glass T-tube was introduced through the mouth into the upper end of the œsophagus, the tip reaching the level of the upper end of the sternum. One arm of the T-tube was connected with a pair of Bidie recording bellows, to the other arm was attached a sensitive valve which would permit the entrance of air when negative pressure existed in the system, but would block its exit. Stop-cocks were so placed that the T-tube could be connected with either the recording bellows or the valve separately, or with both together (Fig. 2).

A hollow needle was introduced into the stomach through a midline abdominal incision and was connected with a second pair of Bidie bellows in order to record any dilatation which might occur.

THE RESULTS—The results of a typical experiment are shown in Fig. 4. The first part of the tracing shows the uninterrupted flow of air into and out of the œsophagus at each respiration. At the point marked by an arrow, the stop-cock was turned, making connection with the valve which permitted the entrance of outside air but blocked its exit. It will be noticed that there was at once an accumulation of air in the œsophagus, causing an abrupt rise in

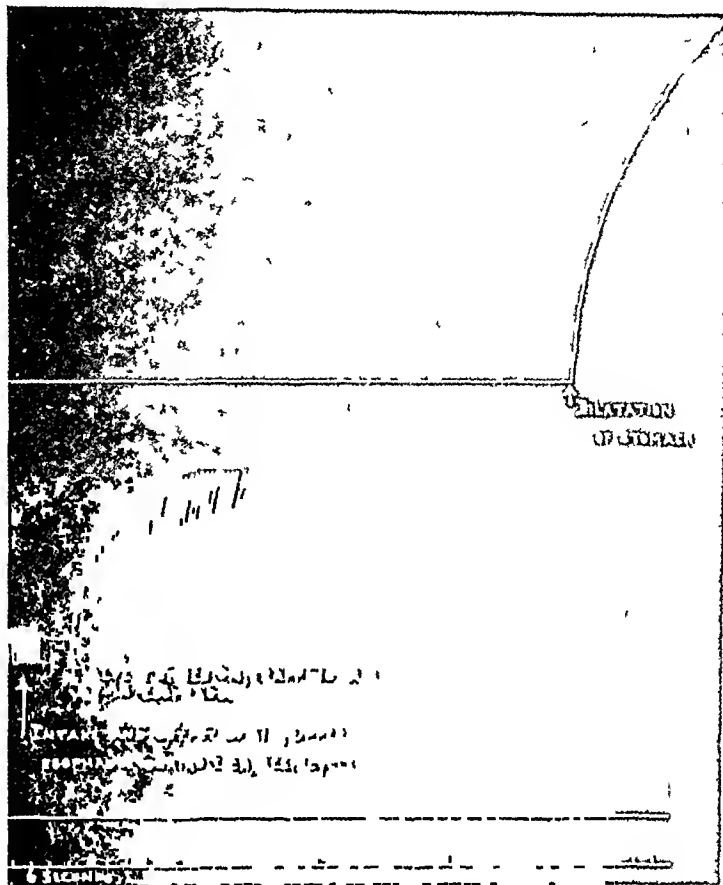


FIG. 4.—The lower tracing is that of the recording bellows connected with the œsophageal tube, the first part showing the movement of air in the œsophagus during respiration. At the point indicated by the arrow the valve (see Fig. 2) was turned on, permitting the entrance of air but preventing its escape. The upper tracing records the movements of the bellows connected with the stomach. It will be noted that about two and one-half minutes after turning on the valve a dilatation of the stomach occurred.

the tracing, and a dilatation of the stomach followed in the course of about two and a half minutes. Further experiments showed this to be a constant result. The dilatation proceeded rapidly until the stomach was several times its normal size. The gaseous content was approximately 250 c.c. of air, which is about five times the amount of air normally found in the stomach of the fasting cat. The pressure existing in the stomach, as determined by a water manometer, was about 6 cm. of water.

DISCUSSION—It is certain that the force which in these experiments draws atmospheric air into the upper œsophagus is the negative pressure in the thorax. The mechanism, however, causing the passage of the air from the

upper œsophagus into the stomach is not so clear. The simplest explanation would be that as pressure increases in the upper œsophagus, the air is forced downward into the stomach, which acts as a reservoir the more readily because its muscle tone is lowered by etherization. The downflow of air through the œsophagus is doubtless aided by the fact, pointed out by Meltzer,¹⁵ † that negative pressure is greater in the lower part of the mediastinum than in the upper.

A second process which may play the most important rôle in passing air into the stomach is the peristalsis in the œsophagus. It must be remembered, as pointed out by Cannon,¹⁶ that in cats, as well as in man, whereas the upper two-thirds of the œsophagus are composed of striated muscle, the lower third is formed of smooth muscle. The peristalsis in this smooth muscle is not abolished by etherization, and it seems quite possible that when the pressure

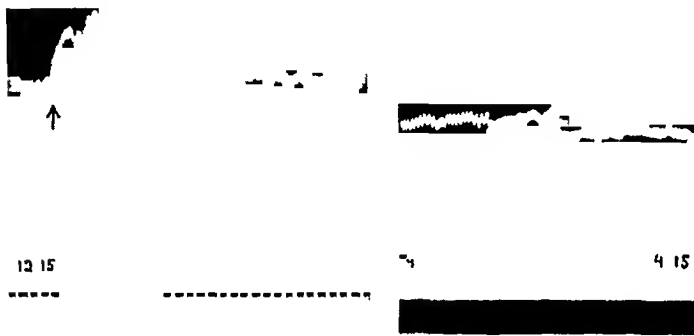


FIG. 5.—Blood pressure taken from the carotid artery. The line at the bottom shows time intervals in five seconds and zero blood pressure. At the point marked by the arrow the stomach was inflated with air. The temporary rise in pressure is a reflex effect, see text. The interval between the two tracings represents a lapse of about four hours during all of which time the stomach was kept greatly dilated. It will be noted that the blood pressure has been well maintained. The animal was in good condition in other respects also.

in the œsophagus reaches a certain level the accumulated air will be carried by a peristaltic wave down into the stomach. If air is injected into the œsophagus by the means of a syringe, it will then be carried down into the stomach by a wave of peristalsis, as can be observed by opening the thorax under artificial respiration.

In applying these experimental data to the cases of dilatation of the stomach which have been observed clinically to occur under anæsthesia, it should be remembered that the experimental conditions here described differ in two major respects from those prevailing in human cases. In the first place, there is actually no rigid tube, as in our experiments, passing down from the mouth to the upper part of the chest, in the second place, there is normally no valve-like mechanism preventing the exit of air from the pharynx. In regard to the first point while under normal conditions the œsophagus is collapsed, under conditions of anæsthesia its upper portions may become air-containing. When this is so, the force of negative pressure during inspiration would draw air into the œsophagus from the pharynx. In some of the cases that have been reported there was respiratory difficulty so marked as to be made part of the record, and since an inspiratory effort in the presence of obstruction to the free passage of air into and out of the thorax increases the

† Meltzer estimated this pressure by placing a cannula at different levels in the mediastinum, alongside of the œsophagus. He states that he was unable to obtain constant readings when he made the measurements in the œsophagus, because of its muscular walls and irregular contractions.

negative pressure, a larger amount of air would be drawn into the upper œsophagus. As regards the second point of difference, the existence of a valve, it seems likely that a dropping back of the soft palate or tongue, in the presence of nasal obstruction, might play such a rôle ‡

Systemic Effects of Acute Dilatation—Clinical observers have for the most part noted few or no systemic effects immediately following gaseous distention occurring under anæsthesia. In a few instances interference with the respiration and increase in heart rate have been noted. In cats, if the stomach be dilated with air, there is at first a rise in systemic blood-pressure which later falls to the normal (Fig 5). This phenomenon has been described by Dmitrenko¹⁷ as a reflex supposed to occur chiefly through afferent fibres in the sympathetic system. As shown in Fig 5, the systemic blood-pressure may remain normal, although the stomach has been kept enormously dilated for a number of hours, the pressure being maintained at about 50 mm of Hg by the injection of air with the cardia and pylorus ligated to prevent its escape.

In view of the clinical observations and experimental work we may conclude that the first systemic effects of gaseous dilatation per se are slight. The disturbances that have been recorded are attributable to mechanical embarrassment of respiration and heart action due to pressure on the diaphragm. If, however, the acute dilatation, whether of the type occurring under general anæsthesia or of any other type, goes unrecognized or unrelieved, the resulting condition is serious. The greatly distended stomach cannot function, it is unable to empty itself either by way of the intestines or through the œsophagus ¶ We have here a condition comparable to pyloric obstruction in rabbits. Since these animals lack the vomiting reflex, the stomach, under the conditions of pyloric obstruction, as pointed out by Gamble and McIver,¹⁸ acts as a reservoir for the large amounts of water and salts that are poured into it by the gastric mucosa, and the animals soon show the effects of dehydration. It seems likely from these studies and from other recent work on high intestinal constriction (White¹⁹) that most of the symptoms which may be encountered in late stages of acute dilatation of the stomach could be explained on the basis of a severe dehydration with the accompanying loss of chlorides and fixed base.

‡ It was suggested in the earlier part of the paper that in the presence of obstruction to the exit of air from the pharynx the intrapharyngeal pressure would be raised, and since the œsophagus opens into the pharynx along with the trachea, air issuing from the glottis might be forced down into the stomach. It is possible to conceive that an obstruction to the free passage of air into and out of the pharynx might play a double rôle during the labored inspiration air would be drawn into the upper œsophagus by the increased negative pressure, and during the strong expiratory effort it would be driven into the stomach by the increased pharyngeal pressure.

¶ The characteristic vomiting in acute dilatation is merely the regurgitation of small amounts

SUMMARY

1 The distinguishing features of acute dilatation of the stomach occurring under general anæsthesia are discussed

2 The gas responsible for the dilatation is shown to be atmospheric air, and the experiments deal with its mode of entrance into the stomach

3 These experiments show that acute dilatation of the stomach of the anæsthetized cat can be produced by placing in the upper œsophagus a glass cannula connected with the air by means of a valve that permits the entrance of air but blocks its exit. The rôles played by the negative pressure in the thoracic cavity and œsophageal peristalsis are discussed

4 The immediate systemic effects of dilatation are shown to be slight. The later effects, in cases that are not relieved, may be serious, and it is suggested that many of the symptoms are due to severe dehydration

BIBLIOGRAPHY

- ¹ Fagge, C H. Guy's Hosp Report, 1873, vol xviii, p 1
- ² Morris, H. Trans Path Soc Lond, 1883, vol xxxiv, p 82
- ³ Conner, L A. Am J Med Sci, 1907, vol clv, p 345
- ⁴ Laffer, W B. ANNALS OF SURGERY, 1908, vol xlvii, p 390
- ⁵ Borchgrevink, O J. Surg, Gynec and Obst, 1913, vol xvi, p 662
- ⁶ Doolin, W. Brit J Surg, 1918, vol vi, p 125
- ⁷ Novak, E. J Am M Assn, 1921, vol lxxvii, p 81
- ⁸ Lee, B J. ANNALS OF SURGERY, 1916, vol lxxiii, p 418
- ⁹ RICHARDSON, W G. Brit Med J, 1913, vol ii, p 1202
- ¹⁰ Kelling, G. Arch f Klin Chir, 1901, vol lxiv, p 393
- ¹¹ Woodyatt, A T, and Graham, E A. Trans Chicago Path Soc, 1912, vol viii, p 354
- ¹² Schierbeck, N P. Skand Arch f Physiol, 1892, vol iii, p 437
- ¹³ McIver, M A, Redfield, A C, and Benedict, E B. Am J Physiol, 1926, vol lxxvi, p 92
- ¹⁴ McIver, M A, Benedict, E B, and Cline, J W, Jr. Arch Surg, 1926, vol xliii, p 588
- ¹⁵ Meltzer, S J. J Physiol, 1892, vol viii, p 218
- ¹⁶ Cannon, W B. Am J Physiol, 1907, vol xix, p 436
- ¹⁷ Dmitrenko, L F. Am J Physiol, 1924, vol lxxiii, p 280
- ¹⁸ Gamble, J L, and McIver, M A. J Clin Investigation, 1925, vol i, p 531
- ¹⁹ White, J C. Boston M and S J, In Press

CAUSES OF DEATH FOLLOWING OPERATIONS FOR PERFORATED GASTRIC AND DUODENAL ULCERS

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It is the general impression that the important factors in determining the death of patients suffering with perforated gastric and duodenal ulcers, are, first, the length of time which has elapsed between the rupture of the ulcer and operative interference, secondly, the proximity of the time of perforation to the ingestion of food with the consequent variable gross soiling of the peritoneal cavity, and thirdly the rapidity with which the operation is performed. As a rule nothing or very little is said of several other factors causing death and yet they are almost as important as the most weighty factor, *ie*, the time elapsed between rupture and operation.

The following considerations are based upon a study of the records of eighty-eight patients from the surgical service of the Mt. Sinai Hospital since January 1, 1915. Many of these patients were personally observed and operated upon by the writer. There has been no attempt to differentiate the duodenal from the gastric ulcers, for in our experience it has been almost impossible, and, indeed, fruitless to tell them apart clinically. Even at laparotomy the landmarks are so obliterated by the products of inflammation when the ulcer is in the neighborhood of the pyloric ring that the term *gastroduodenal* must be used. The constriction at the duodenal-pyloric junction and the pyloric vein are not usually visible.

Of these eighty-eight patients, twenty-seven died, *ie*, 31 per cent. The death rates in the practice of surgeons in different hospitals and in different localities vary considerably, for there is not nearly the uniformity in percentage of mortality as in the case of other more common surgical diseases such as acute appendicitis. From year to year the mortality changes, so that in one the rate is zero, and in another as high as 54 per cent. A comparative study of death rates in perforated gastroduodenal ulcers is of little importance. Perforated gastroduodenal ulcer is such a catastrophe in which the peritoneal cavity is suddenly and frequently, overwhelmingly invaded by a hostile horde of chemical and bacteriological forces, that the outcome depends more upon the strength of these forces and the patient's ability to cope with them than upon the act of the surgeon.

The Duration of Time Between Rupture and Operation—Our records agree with the universal experience that the mortality increases almost in direct ratio to the number of hours elapsing between rupture and operation.

Because this factor is so sure and so well known it requires little comment.

It is very striking, indeed, that not a single patient died when operated upon within six hours after perforation. This factor of the lapse of time between perforation and operation needs qualification. There is a small group of

TABLE I¹

Hours after perforation	No. of patients	No. of deaths	Per cent. of deaths
to 6	27	0	0
7 to 12	26	7	27
13 to 24	12	3	25
25 and above	19	14	73

¹ When the total number of cases in this and the other tables is less than the total 88 the relevant data have not been available in the missing cases

patients who come to operation more than twelve hours after perforation, but in whom there is little or no spilling of stomach contents and only a localized inflammatory reaction. This is illustrated by the following case history:

Morris D, age thirty-seven years (operation by Dr. J. B. Stenbuck, 1923), stated that he was suddenly seized with severe epigastric pain thirteen hours prior to operation and that the pain persisted, though after several hours somewhat abated, to the time of admission to the hospital. On physical examination, the signs were those of marked peritoneal irritation including the usual board-like rigidity. When the abdominal cavity was opened there was no escape of either air or fluid, and, indeed, no inflammatory reaction was seen. A tab of omental fat was adherent to the anterior surface of the antrum of the stomach in the region of the pyloric ring. Only upon detaching this tab of fat was it possible to see the ulcer which then began to emit gas and gastric contents.

In this instance there had been apparently an acute perforation of the ulcer thirteen hours prior to operation, but a tab of fat had walled it off by acting as a stopper to the gastric contents. We must differentiate this type of case from that in which there might have been for thirteen hours a more or less constant outpouring of gastric or duodenal contents into the peritoneal cavity and in which the outcome is obviously unfavorable. It is the type of case illustrated by Morris D, that we may expect to find not infrequently that the patient has recovered from operation even though operated upon long hours after perforation. This type of case is in marked contrast to the more common type in which there occurs a virtually continuous explosion. The exact time of walling off is practically impossible of estimation, though the cessation of the severe abdominal pain is suggestive of it. In our records not infrequently there is a history of short periods of acute epigastric pain with remissions for one or two weeks prior to the very acute attack which sends the patient to the hospital. Possibly on the previous occasions there have been heroic attempts on the part of the omentum and the serosa to seal the orifice of the perforating ulcer. There may have been a succession of mild perforations, temporarily walled off, ending, however, in rupture into the free peritoneal cavity. There is a case operated upon as much as three days after time of apparent rupture in which there was recovery.

PERFORATED GASTRIC AND DUODENAL ULCERS

Thomas T, age forty years (operation by Dr R Lewisohn, 1917) His history, typical of ulcer, extended over a period of five years prior to admission, during which time there were attacks similar to the present of severe epigastric pain occurring at intervals of about six months The last attack began about three days before admission and was more or less continuous At operation a small amount of serous fluid was found in the peritoneal cavity, but there was no peritonitis There was a perforation, pinhead in diameter

Another case operated upon twenty-eight hours after rupture affords unusual interest

Isadore L, age forty-two years (operation by Dr J C A Gerster, 1924), had an attack of severe epigastric pain two years previously, similar to the present one, and it lasted in varying degree about two weeks There were several milder attacks in the interim The present attack began twenty-eight hours before admission and continued with varying intensity until time of operation Just before operation a roentgenogram showed free air in the peritoneal cavity between the diaphragm and the liver At operation free gas escaped from the peritoneal cavity and there was a small amount of peritoneal fluid *No perforation* was found, although obviously it had occurred Thick yellow fibrinous exudate covered a small area on the surface of the antrum of the stomach and beneath it was the induration of an ulcer The presence of the ulcer was corroborated when, in the performance of gastro-enterostomy, a finger was introduced into the lumen of the stomach

In addition to qualifying the factor of time elapsing between perforation and operation, these cases suggest very strongly the probability that perforated ulcers may heal spontaneously At least they demonstrate in some cases the importance of physical resistance as compared with surgical assistance in rescuing the patient from death

The Operative Procedure—The majority of surgeons are in favor of the simplest form of operation which is closure of the ulcer in two or three layers They reserve gastro-enterostomy for those cases in which the marked constriction of the pylorus whether due to either operative suture, or scar tissue, or oedema requires it This adherence to a simple procedure is in harmony with the customary teaching that for the good of the patient it is urgently advisable to "get in and get out" of the abdominal cavity with the utmost rapidity Of twenty-eight patients of various stages upon whom a gastro-enterostomy was performed in addition to closure of the ulcer, only four died, a mortality of 14 per cent Many of these were advanced cases with peritonitis The mortality is low in comparison with 31 per cent in all our cases and suggests the possible beneficial effect that may have been brought about by improved drainage by way of the gastroenteric stoma

In the absence of constriction in the pylorus or duodenum, closure of the orifice when properly performed will suffice The proper closure does not entail any elaborate suture It is possible that one purse string inserted into firm tissue will be enough to prevent further leakage of gastric or duodenal contents and allow the ulcer to heal The following case is of interest in this connection

Raymond M, age twenty-four years (operation by Dr J B Stenbuck, 1925) A perforation occurred on the anterior surface of the stomach near the pylorus There was

The Three Periods or Modes of Death After Operation—In Fig 1, I have grouped the deaths according to the time they occurred after operation (Fig 1)

It will be observed that one group is composed of patients who die within three days after operation, another is made up of those who die about a week (six to ten days) after operation, and a third of those who die one to two months after operation. These are not, in my opinion, chance

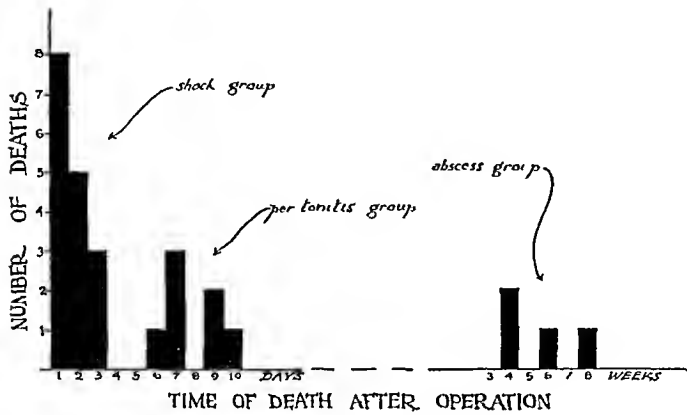


FIG 1

groupings. I believe they represent three different modes in death which may be differentiated clinically and pathologically.

GROUP I—In those patients who die within three days (mostly within one day) after operation, the preponderant factor in *shock* which is notice-

able before operation and continues unabated until death after operation. While autopsy may reveal a diffuse soiling of the peritoneum and early peritonitis, it is *as a rule* too early and too slight to cause death. This overwhelming chemical and bacterial shock is exaggerated according to the patient's inability to cope with it. Some patients may overcome it and survive, some others may overcome it temporarily only to succumb later, according to their powers of resistance. We should expect to find in Group I the patients of advanced age and those with chronic organic disease. It is interesting to note that of the sixteen patients who died within three days post-operative, twelve were fifty years old, or older, and only four were below fifty years of age. Because of their lessened reserve they die very easily in pulmonary, cardiovascular, or renal collapse rather than from infection *per se*. In this group the patients make their exitus in a violent sort of death. There is no free interval in which the patient feels improved by the operative procedure, but he is desperately sick every minute from the onset to the end of his very short illness.

GROUP II—In the second group the patients die of a generalized purulent *peritonitis*. They pass through the period of shock very quickly. They feel better after operation and they seem to be combating the disease successfully for a few days so that the surgeon is tempted to make a favorable prognosis. Then very surely the patient's temperature mounts, the pulse becomes more rapid and labored, and the expression anxious. These signs of peritonitis are followed by death. In this group are the younger patients who are sufficiently vigorous to withstand the early shock, but are unable to ward off the infection which spreads. Of the seven cases of death in this peritonitis

group, the age distribution was as follows only two patients were above fifty years of age, and five patients were less than fifty years of age

GROUP III —The third may be termed the *abscess* group The abscess may be subphrenic or within the liver In our cases there were two deaths of each variety In the case of liver abscess the patients pass successfully through the periods of shock and of peritonitis and at the end of the second or third week they may appear quite normal and ready for discharge when they begin to experience pain in the abdomen just beneath the operative wound or in the region of the liver The temperature and pulse rise and there may be a chill or chilly feeling with a cold clammy perspiration Abnormal pulmonary signs usually at the right base may be elicited and are due, as a rule, to the elevation of the diaphragm and the production of some pleural fluid which later may become purulent The abscess becomes larger and larger There may be several abscesses The condition does not respond to surgical treatment mainly because of the difficulty in draining abscesses which are multiple, and with gradually increasing toxæmia and cachexia and actual destruction of a considerable amount of liver substance, the patient dies in one to two months post-operative

Subphrenic abscess as a complication of perforated ulcer causing death is mentioned not uncommonly Most probably its origin may be explained by a purulent residuum over the dome of the liver, or by a superficial liver abscess which has ruptured beneath the diaphragm

Liver abscess, on the other hand, as a factor in death after operation for perforated ulcer is an unusual condition and has received scant mention or none at all in the clinical and pathological considerations of the subject We have been unable to find any report of such cases in the literature though it is possible that some of the cases of subphrenic abscess reported were originally liver abscesses which ruptured The possible modes of infection in liver abscess are 1 By way of the portal vein from the ulcer, from the peritoneal infection, or from the infected abdominal wound 2 By direct extension from the ulcer which may lie contiguous to the liver, and 3 From a suppurative cholangitis

Clinically the condition was not diagnosed at its onset but attention was called to the subphrenic abscess which overlay it in each of our two cases In one, the presence of the subphrenic abscess masked the liver abscesses which lay beneath it and it was only by aspiration of the liver at the time of operation for drainage of the subphrenic abscess that the presence of the abscesses in the organ could be elicited In the other case the liver abscesses were discovered at post-mortem examination

CASE I—G F, age fifty-eight years (operation by Dr E Klem, 1923), was operated upon May 5, and died July 4 For five or six years prior to admission he had had stomach trouble which consisted of epigastric pain with sour eructations occurring about two hours after meals, which were relieved by bicarbonate of soda Nine hours before admission he had an attack of severe epigastric pain Before operation physical examination showed generalized abdominal rigidity and tenderness more marked in the epigastrium and obliteration of the area of liver dullness At operation the upper abdominal cavity con-

tained a moderate amount of sero-purulent fluid. On the anterior surface of the pylorus was a perforation 3 mm in size, surrounded by an acute inflammatory process involving the wall of the stomach. The orifice of perforation was sutured and because of the constriction of the pylorus a posterior suture gastro-enterostomy was performed. A soft rubber tube was placed as a drain in the region of the foramen of Winslow.

May 7, signs of pneumonia developed at the left base.

May 22, there were signs, corroborated by roentgenograms, suggestive of a subphrenic abscess but aspiration revealed no pus. The condition of the patient became progressively poorer. A mild fever (90° F to 100° F) persisted until the middle of June when the temperature rose daily to nearly 103° F and continued to do so until death on July 4.

July 2, a preliminary walling off of the pleural cavity was performed and on July 3, the subphrenic space was entered and a small abscess in it was drained.

July 4. Post-mortem examination showed a healed gastric ulcer. There was no pus present in the abdominal cavity, but many adhesions had formed between the inferior surface of the diaphragm and the dome of the liver. In the uppermost portion of the liver substance, immediately beneath the surface was an abscess 6 cm in diameter. There were two small abscesses having a diameter of 1 to 2 cm close by. The intervening liver tissue showed irregular areas of dark red infarction. The gall-bladder, the bile ducts, the portal vein and the hepatic vessels were grossly negative.

CASE II—B. G., age thirty-seven years (operation by Dr. J. B. Stenbuck, 1924), was operated upon October 8, and died November 26. His previous gastric history of only two weeks' duration consisted of mild, constant, non-radiating epigastric pain not related to meals. Eight hours before operation there was a sudden attack of very severe epigastric pain. Physical examination showed signs typical of perforated gastroduodenal ulcer. Operation revealed a perforation about 0.5 cm in diameter on the anterior surface of the antrum near the lesser curvature. The perforation was closed by means of three layers of sutures. In the upper portion of the abdominal cavity there was a large collection of bile-stained, thick fluid which extended above the dome of the liver. The fluid was mopped with sponges and aspirated. A soft rubber tube was placed to the region of the pylorus.

Immediately after operation the patient developed signs of diffuse bronchitis which disappeared in a few days.

October 18, thick pus was evacuated from the lower part of the abdominal wound. The patient's temperature became normal and he appeared to be quite well and ready for discharge from the hospital as soon as his wound should heal.

October 26, the patient experienced pain in the right hypochondrium and right flank, and there was tenderness in this region. The pain continued, the temperature rose sharply to 103° F, and there were flatness and diminished breath sounds in the lower portion of the right chest. These signs and symptoms suggested a subphrenic abscess. A roentgenogram showed a slight elevation of the right diaphragm with increase in the lung markings at the right base which were probably due to compression.

October 29, aspiration was performed in the tenth interspace in the midaxillary line, which was the point of maximum tenderness, and a few drops of very thick pus were obtained.

November 2, the subphrenic space was entered, pus evacuated from it, and drainage instituted. Nevertheless, the temperature continued elevated, and therefore the wound was revised and another pocket of pus discovered apparently in the liver substance. The fever remained high.

November 9 and November 13, the wound was reentered and the liver was penetrated by the aspirating needle and pus was obtained beyond what appeared to be grossly healthy liver tissue. The barriers of liver substance which separated what were evidently multiple liver abscesses were broken down to form one large cavity. However, the abscesses which went to form this cavity had destroyed almost all of the right lobe of the liver.

The patient became rapidly worse and died November 26.

These cases of death from liver abscess present similar pictures. Most probably infection brought to the liver by way of the portal vein, proliferated in the small branches. Although the quantity of bacteria might be quite small they would, in the weeks of illness, finally produce large abscesses. Although the bacteria might be diffusely disseminated throughout the liver, they might not produce diffusely disseminated abscesses but only multiple purulent foci. It is possible that the smaller abscesses might coalesce to form larger ones.

Clinically, in the onset of development of these abscesses, it is remarkable that there may be no abnormal signs. Yet this is in conformity with the occasional experience in liver abscess not related to operation, in which the physical signs and symptoms are almost negligible. Indeed, it is most probable that the condition does not present itself to us until a subphrenic abscess is formed, due possibly to the subdiaphragmatic rupture of a superficial liver abscess.

In each of our cases the abscesses of the liver were multiple, in each they seemed to have become progressively worse and involved a considerable quantity of liver substance, and each did not respond to operative treatment. In the nature of the multiplicity and dissemination of the abscesses and the impossibility of draining all of them, operation will offer no hope of succor.

SUMMARY

The time which has elapsed between the time of rupture of a perforated gastroduodenal ulcer and the time of repair is the most important factor in determining the fate of the patient. There are, however, other factors of considerable importance: age, the type of operative procedure, the repair on the part of the omentum, the size of the perforation, the amount of gastric or duodenal contents spilled, organic disease, and alcoholism.

After operation death occurs in three distinct groups. In the first group, death occurs within three days, usually within twenty-four hours, after operation, and is due almost entirely to the element of *shock*. In the second group, the patients appear to be improving, only to succumb to diffuse *peritonitis* in approximately a week after operation. In the third group, the patients after overcoming the elements of both shock and peritonitis die in several weeks or months after operation, due to subphrenic or liver *abscess*.

Death from abscess of the liver occurred twice in our series of eighty-eight cases, and since it is an extremely rare condition both cases are here recorded.

TUMORS OF THE CÆCUM *

DISCUSSION AND REPORT OF FORTY-EIGHT CASES

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AMONG the more common varieties of tumors of the cæcum appearing in the literature of the day are cystic, including dermoid, epidermoid and entero-cystoma with tumors of the following varieties—leiomyoma, actinomycosis, lympho-sarcoma, carcinoma—standing out most prominently with tuberculosis, chronic inflammatory hypertrophy and the occasional lympho-sarcoma. We mention the latter in the order of frequency in which we have seen them.

Carcinoma was found in thirty-seven instances, tuberculosis in seven, chronic inflammatory in two and lympho-sarcoma in one. One undetermined possibly following appendix phlegmon.

For the sake of completeness, a brief review of anatomy with emphasis on the cæcal lymphatics is necessary.

Anatomy—In a normal adult the cæcum is about two and one-half inches in length. A fold running from the top of the ileum partly around the large gut, marks the boundary between the cæcum and the colon. The cæcum differs from the rest of the large gut in that it is more richly supplied by the lymphatics. It is lined with a single layer of columnar cells—Villi and valvulæ conniventes are absent.

The vessels of the mesentery and nerves enter the cæcum and colon from the inner or left side. This may be explained embryologically since the cæcum and the colon originally occupied the left lower abdominal segment, later they rotate to the right, remaining permanently in the right iliac fossa.

The blood supply to the cæcum is the ileo-colic branch of the superior mesenteric. The ascending colon is supplied by the right colic, and the transverse colon by the medial colic.

The lymphatic drainage follows the course of the ileo-colic blood-vessels. Frequently they are continuous with glands around the superior mesenteric artery. The terminations are associated with the ileo-colic arterioles.

Lymph channels surround the glands of Lieberkuhn where carcinoma of the cæcum originates. From here they are directly continued to the network of the lymphatics in the submucosa. These pass through the muscle layers and form plexuses of lymphatics between the mesenteric sheaths.

* Read before a conjoint meeting of the New York and Philadelphia Surgical Societies, February 9, 1927.

The lymph systems may drain into five different groups of glands about the cæcum or directly into the glands around the ileo-colic artery above

The groups as given by Craig and MacCarty are 1 Anterior colic
2 Posterior colic 3 Appendicular 4 Ileal 5 Right colic

Lympho-sarcoma—Lympho-sarcoma is an extremely rare disease of the cæcum. During a period of fifteen years in Prague, of 13,036 sections, thirteen cases were found. It does, however, occur with more frequency in the small intestines and rectum.

The symptoms are similar to other types of cæcal tumor, occurring in early adult life. The tumor is extremely rapid growing and non-tender.

It begins in the submucosa made up of small or large round cells. Within a very short time the entire gut wall is infiltrated. The central portion breaks down and ulcerates. Extension takes place peripherally. With sarcomatous invasion the gut has a tendency to be dilated rather than to be constricted in contra-distinction to carcinoma. Polypoid excrescences are not usual.

The course is rapidly fatal. Metastases occur early in the contiguous lymphatics and likewise in the distant organs.

Early recognition and excision followed by Röntgen and radium therapy offers the best prognosis. A few cures have been reported.

In our series we had one case reported to be lympho-sarcoma.

Tuberculosis—There is now rather general agreement that tuberculosis does occur primarily as well as secondarily in the cæcal region. The pathological differences are quite marked. This in a given case, together with absence of tuberculous foci in the other regions, furnishes strong support for those contending primary invasion.

Tuberculosis of the cæcum is very common in patients having pulmonary involvement. At necropsy it has been demonstrated that the gastro-intestinal tract is involved in 70 to 90 per cent of these cases. (Hartman quoted by Menzies.) Of this number the ileo-cæcal region is involved in about 85 per cent of the instances. Only a relatively small number of this group receive surgical interference, and then only when symptoms of obstruction, fistulæ and severe subjective signs are present.

The best explanation offered for the predelection of the ileo-cæcal region is based on anatomy. As cited previously the cæcal region of the large gut, excepting the rectum, is the most abundantly supplied with lymphoid tissue. In children the infection is attributed to milk inoculation by the bovine type of bacillus. In adults it is ingested with the food, or transmitted through the blood stream, and the organism is the human type.

The age incidence is early adult life between the second and third decades, although of our series of seven cases reported, the average age was under twenty years. As regards sex there was equal distribution.

There is nothing in the symptomatology characteristic of tuberculosis unless it be the insidious onset, chronicity and interval periods of freedom.

from symptoms The duration in our series extended from two months to five years

Pain is an early evidence, full at first, later cramp-like and irregular Associated with this is tenderness and rigidity in the right lower quadrant Obstinate constipation with diarrhoea and blood-streaked mucous shreds is a prominent symptom Epigastric discomfort, nausea, vomiting and belching occur early The absence of temperature means little, its presence, particularly in the afternoon, may augment the differential diagnosis

Serum tests in adults are of very little aid Pulmonary, osseous and glandular involvement must always be sought for We were able to demonstrate phthisis in one instance, and no extra-cæcal focus in the others

Brown, Levy and Haft all emphasize the difficulty of clinical recognition, and stress the value of the Rontgen examination, also see the article by J W Lairmore and A O Fisher, *American Surgery*, p 496, April, 1926 The former reports that in twenty-eight cases diagnosed and operated, twenty-seven were diagnosed correctly His work upon this subject has been painstaking and most illuminative The Rontgen picture in cæcal tuberculosis reveals hypermotility, spasticity, and filling defect Obstruction when present is likewise disclosed

Pathologically, there are two distinct types of cæcal tuberculosis (1) Ulcerative, (2) Hyperplastic

(1) Ulcerative Menzies describes this type as the enteroperitoneal group The tubercles are first found in the mucous membrane As they grow they coalesce, undergo central degeneration and produce superficial flat ulcers with undermined edges Read states that the ulcers circle the gut because the lymphatics and vessels run circularly As a result, on healing the cicatrix forms an obstructing band He maintains that 25 per cent of the ulcerous type produce stricture or stenosis Similar tubercles in the serosa produce a dense adhesive peritonitis This group is considered a secondary manifestation of a primary focus elsewhere It is surgical only when obstruction makes intervention imperative

(2) Hyperplastic This group is considered to be primary in origin Surgical excision frequently perfects a cure The tubercles appear in the submucosa, growing there, causing thickening of the wall and narrowing of the lumen Menzies claims that by the fibrolipomatous changes in the pericæcal fat there is a tendency to self-limitation of the tumor

Our cases represent both these types of tumor and secondary infection had played an important part in the syndromes All cases showed degrees of obstruction Three were of the hyperplastic type, one of which was complicated by a fecal fistula Two showed papillary projections of the mucous membrane One was of the ulcerous, constricting type with the primary focus in the right middle lobe of the lung It is interesting to note that all had at various times been diagnosed as appendicitis Two had had appendectomies, one of which resulted in the fecal fistula mentioned above

and this latter one was a primary perforation of a tuberculous ulcer of the cæcum

A Friedrick resection with a side-to-side anastomosis of ileum to transverse colon was done in one stage in three instances. Because of the extreme dilatation of the ileum in the ulcerative case, only the resection of the tumor and an ileostomy (Paul's tube) was attempted at the first stage. Eleven days later the anastomosis was completed similar to the others.

The results were uniformly good. There was one death out of seven patients, a child two and a half to three years old, with tuberculosis of the cæcum, who had an appendectomy done, the other patients leaving the hospital apparently cured. Responses to follow-up letters revealed freedom from symptoms and marked general improvement.

Carcinoma—In this series of cases the youngest was twenty-one and the oldest seventy-eight. Attention has been called to the fact that carcinoma of the intestinal tract occurs with far greater frequency in the fore-gut and the hind-gut. The mid-gut, extending from the second portion of the duodenum to the ileocæcal valve is relatively free from invasions. It seems, therefore, that that portion of the gut functioning to prepare and digest food and also that portion which has to do with the storage and evacuation of unassimilated food is peculiarly susceptible to carcinomatous invasion.

Brill (quoted by Ewing), in reporting 3563 cases of malignancy of the intestines, found only eighty-nine, or 2.5 per cent, of instances in which the small intestines were involved. Of this number, the greatest percentage occurred in the second portion of the duodenum about the biliary papilla.

In an article by J. F. Eidmann and R. F. Carter, *New York Medical Journal*, June 7, 1922, the senior author reports the following frequency of malignancies of the colon in a series of one hundred and twenty-nine cases. Fifty in the recto-sigmoid, rectum and anus, thirty-seven in the sigmoid, eighteen of the cæcum, fifteen of the ascending colon, hepatic flexure and right half of the transverse colon, nine cases in the left half of the transverse colon and splenic and descending colon.

Tissue predisposition is evident in those instances in which malignant changes develop from polyps of the colon. Trauma due to physiological and anatomical relationship plays a definite rôle. No doubt those portions of the gut which are fixed and offer more resistance to fecal movements are subjected to a more constant irritation. This resistance probably being greatest at the ileo-cæcal junction and at the rectal valves.

Pathology—Tumors of the cæcum are characteristic of tumors elsewhere in the colon. They are slow growing, only moderately malignant, extending late and metastasizing less frequently than tumors of a similar nature in other organs.

Carcinoma begins in a circumscribed area of mucosa, with enlargement of the glands and permeation of the basement membrane. This area gradually extends by progressive transformation of normal into neoplastic alveoli.

Microscopically this process can be demonstrated and one may frequently see papillary outgrowths of mucosa surrounding an ulcerated tumor

Ewing gives the following gross and microscopical classification

1 Adenoma Destruens —A bulky ulcerating tumor causing obstruction, fistulæ and anastomosis

2 Stenosing Fibro-carcinoma —First produces a superficial ulcer with marked fibrotic induration. It has a tendency to be annular, causing constriction of the lumen and infiltrating tissue and nodes early

3 Colloid Gelatinous Adenocarcinoma —Bulky, spreads rapidly and ulcerates early. This type produces miliary nodules in the peritoneum. Lymphatics are involved later

4 Multiple carcinoma from polyposis

5 Papillary carcinoma from single polyps

6 Melanoma

Colloid carcinoma or gelatinous of Ewing, differs from adenocarcinoma only in that it is a degenerating form. Parhan describes it as lack of functional control of the secreting epithelial cells. This functional differentiation of cells corresponds to morphological differences seen in carcinoma cells of the acinar or columnar type. He observed colloid carcinoma in 22 per cent of all malignancies of the cæcum. In our series, with a recent pathological "check-up" of specimens, we found only 18 per cent conforming to the type.

Metastasis is rather late and recurrence is usually found at the site of origin. Death may be delayed in colloid carcinoma but the eventual mortality is greater than in other types. Parhan points out that the signet ring cells tend to be more malignant than the glandular type with columnar growth.

The most frequently involved group of lymphatic glands are the posterior colic. In the Craig and MacCarty series of one hundred cases studied with particular attention paid to glandular distribution, 71 per cent of all glands found were in this region, and 64 per cent of the glands showing metastatic involvement belonged to this group.

This may be explained by the frequency of involvement of the ileo-cæcal valve in malignancy of the cæcum (50 per cent Ewald to 64 per cent Craig) posterior wall alone in 35 per cent. When the valve was involved in the growth and regional metastases were found, the posterior colic chain showed tumor cells in 78 per cent. The surgical significance of the group is at once apparent.

Craig and MacCarty concluded, "The size of intestinal lesions and the size and number of regional lymph-glands proved to be no criterion for the presence or absence of metastasis." They found regional glandular involvement in 32 per cent of their one hundred cases.

Many glands are hyperplastic, œdematous and simulate malignancy, only to be found on biopsy to be inflammatory reactions. In our series in 25 per cent we were able to demonstrate carcinomatous infiltration. Furthermore, cases which clinically are of the low malignant variety tend to have larger and more numerous hypertrophic glandular changes. When the glands are

involved in the carcinomatous process, clinically the picture is more severe and the prognosis as to cure much more unfavorable

Secondary infection invades tumors early and plays a leading part in the rapidity of growth and formation of fistulæ and production of peritonitis. The tumor seldom is the direct cause of death. Cachexia and the resultant death are due primarily to superimposed infective processes. This is especially true in the cæcum, in this region the bacterial fermentation and putrefactive processes reach a maximum of activity. Given the seed for inflammatory reaction, it follows that they will grow rapidly in gut soil already weakened in resistance by malignant degeneration.

We found regional gland metastasis in 25 per cent of our cases. The ileo-cæcal valve was involved in about 48 per cent of instances, and one-half of these showed lymphatic invasion. The entire wall was infiltrated in 62 per cent. Ulceration was present in about 40 per cent. Five specimens revealed infiltration of a portion of the appendix. Multiple polyps were present in six instances.

Distant metastasis in other viscera outside of the colon were not discovered. The liver was never found to be the seat of secondary growths. This is in accord with other observers.

Signs and Symptoms—Seldom is the surgeon consulted in the incipency. Rarely do the symptoms manifest themselves before secondary inflammation or obstructions occur.

This fact is clearly demonstrated by our series in which the earliest duration of symptoms was given as ten days. In delving into the past history however, the patient admitted having had indefinite pain in the right lower quadrant for four years, melena irregularly for one year, and loss of ten to fifteen pounds in weight during that period.

He appeared before me two days after an acute attack of pain, nausea, vomiting and detection of a mass six cubic centimetres in diameter in the right abdomen. At operation a very extensive carcinomatous process was found. The tumor began in the cæcum, involved the valve and extended into the proximal portion of the colon. The lumen was filled with ulcerated papillary projections and the entire wall infiltrated by the growth.

The longest duration of symptoms was fifteen years. This patient had complained of mild "stomach trouble" for that length of time. Three weeks previous to admission he had noticed a mass and then had consulted a surgeon. The average duration of symptoms was one and one-half years to two years.

The symptoms are actually due to secondary complications and may be divided into subjective and objective signs.

A Subjective Signs—We include in this group Pain, constipation alternating with diarrhœa, distention, nausea, vomiting and weakness.

Pain—Admittedly a late symptom was present in 80 per cent of our cases. About one-half of the number maintaining it to be the first indication of disease. It was described usually as a gradual onset of a dull ache. The

location most often mentioned was the right side, chiefly the right lower quadrant or just to the right of the umbilicus. Radiation was inconstant, either absent or down the right leg or toward the umbilicus. Food held no relationship to it. Pain increased in severity during the night hours. Evacuation of the bowels gave the most relief. The pain beginning gradually as a dull ache, steadily increased in character to colicky attacks and sharp piercing qualities. This development may be due to various phases of pathology. Beginning with ulceration through obstruction and to the penetration of the peritoneal nerves by the tumor mass.

Constipation, increasing in severity, was declared the next most frequent symptom. Alternating diarrhoea was mentioned in only three instances, which leads us to conclude that it is not as characteristic of cæcal tumor growths as it is of tumors more distal in the colon.

Distention, nausea and vomiting, all signs of degrees of obstruction, occurred with about equal frequency in about one-third of the cases observed.

Weakness and anorexia was present in approximately the same number.

B Objective Signs—In this group we include loss of weight, presence or absence of mass, tenderness, melena, stiffening of gut, visible peristalsis and anæmia.

Loss of weight was present in about 79 per cent of instances, varying in amount from five to thirty pounds. Associated with this, there was severe weakness and anæmia. The average hæmoglobin reading being 69 per cent, the red cells numbered three million nine hundred thousand. About an equal number of cases showed either a corresponding diminution in the white cell count or a slight leucocytosis seldom exceeding eleven thousand. A mass was found in one-half of the cases, usually fixed to a degree posteriorly. With one exception tenderness was always elicited when a mass was present.

Melena, a rather constant finding in tumors higher in the colon, was present in one out of four cases. A search for occult blood should be made, though, as aforementioned, we feel that a positive finding is less frequent in cæcal growths.

Stiffening of the gut, excluding masses found, and visible peristalsis were noted frequently.

In addition to the above signs and symptoms we have the aid of the Röntgen-ray. It is impossible not to regard Röntgen-ray examination of paramount importance in suspected cæcal disease. Unquestionably in the detection of early involvement it stands first in value as an aid in diagnosis.

In our series, in every case subjected to Röntgen examination, either with the preliminary barium meal or the colon enema, cæcal pathology was discovered and in the vast majority of instances, an accurate diagnosis was made pre-operatively.

The usual findings in cæcal carcinoma were a filling defect or a change in the normal contour. A lack of contrast mixture in the cæcum was a frequent finding. Absence of peristalsis in the cæcum with hypermotility

in the colon was a very constant picture. In addition, distention of the distal loops of ileum was found with varying degrees of obstruction.

Operation—We prefer the Friedrick operation for tumors of the right side of the colon and consequently have performed this technic in twenty-seven of the cases reported. It consisted of the removal of ten to twelve inches of the ileum, the entire cæcum, the ascending colon and from one-third to one-half of the transverse colon, completed by an anastomosis of the ileum to the transverse colon, end-to-end being the choice. A side-to-side anastomosis is the operation of choice in the very fat endowed colon. End-to-side anastomosis was done in three of the recorded cases.

We have not had occasion to use the methods of precaution against gas distention as advocated by Dr. Charles Mayo.

Results following the Friedrick technic have justified our preference for it. Of the 28 cases we had six deaths, or a mortality of 21.4 per cent. The post-operative convalescence was relatively easy, and the follow-ups were satisfactory.

Ileo-colostomy was resorted to on four occasions. One with anastomosis of ileum to transverse colon, three ileum to sigmoid. One patient had had an ileo-sigmoidostomy made six months previously which was not disturbed at the second operation, where removal of the growth was done. On two occasions the growth was not resected, only a palliative short circuit was attempted. One recent recurrence from another city—two years after operation with obstruction. (Collor.) An ileo-sigmoidostomy done.

A delivery of the tumor after the method of Mikulicz and subsequent closure of the artificial anus, resulted in one death out of two cases.

Four instances of complete intestinal obstruction rendered resection impossible and a temporary ileostomy was made with a Paul's tube inserted into the ileum, resulting in two deaths.

A plastic on the cæcum with local resection of a benign tumor was done in one instance and resulted in permanent cure. This is not added to the total number.

We were unable to find the type of operation done in one case with carcinoma complicated by obstruction, which resulted in a mortality. In two instances appendectomies had been done within a period of five years and both patients stated that they had not been feeling well since that time. At operation in each instance the growth was very extensive. This might suggest the possibility of an early tumor presenting the symptoms of an inflamed appendix and having been overlooked. Attention to such has been cited by John F. Erdmann.

Another case had had a resection of a portion of the transverse colon eight years before, and was entirely well until six months before we had an opportunity to see him. At operation an extensive colloid carcinoma was found with regional glandular metastases. Moreover, in the colon, forty-nine centimetres from the cæcal growth, a nodule twenty-five by ten millimetres was found to be of similar pathology. Here again, since we know

that colloid carcinoma is sluggish in growth, we may infer that the cæcal tumor might have been present and passed unnoticed by the operator

SUMMARY

Forty-eight cases of cæcal tumor were studied. Carcinoma was found in thirty-seven instances, tuberculosis in seven, chronic inflammation in two and lympho-sarcoma in one, one undetermined.

Other tumors occasionally found are cyst, gummas, lipomas, tuberculomas, papillomas, cholesteatomas, leiomyomas and actinomycosis.

The ileo-cæcal region is the site of predilection for tuberculosis, because of the right lymphatic supply.

Three of the seven tuberculosis cases were of the hyperplastic type without a demonstrable primary focus. The fourth had an involvement of the right lung and the cæcal growth was considered to be secondary. Three others were tuberculomas.

The Friedrick resection was performed in all the tuberculous tumors, with no mortality and a symptomatic cure. Only appendectomy was done in three tuberculomas.

The cæcum has a predisposition to malignant degeneration because of its physiological and anatomical relationship.

Regional glandular metastasis was found in 25 per cent of the cases reported. The ileo-cæcal valve was involved in 48 per cent.

The signs and symptoms most frequently found were pain, loss of weight, a mass and marked anæmia. Röntgen examination was the most accurate aid in diagnosis.

The Friedrick operation was the method of choice, being performed in twenty-eight of the thirty-seven cases of carcinoma, with a mortality of 21.4 per cent.

CONCLUSION

Carcinoma is the most frequent cæcal tumor requiring surgical intervention. Lympho-sarcoma is the most highly malignant tumor.

Cæcal carcinoma are slow growing and only moderately malignant. Secondary infection invades the tumor early and is the chief cause of the profound cachexia found in these cases.

Distant metastases are rare in carcinoma of the cæcum.

Secondary intestinal growths are not uncommon and should always be sought for. A malignant tumor obstruction may simulate a chronic appendicitis.

BIBLIOGRAPHY

- ¹ Sistrunk, W. E. Carcinoma of Cæcum and Ascending Colon. *S. Clinic N. America*, June, 1925, vol. v, pp. 725-729.
- ² Sevan, T. S. Case of Lympho-sarcoma of Cæcum. *Radiology*, July, 1925, vol. v, p. 71072.
- ³ Hagyard, C. E. Lympho-sarcoma of Appendix and Cæcum. *Northwest Med.*, July, 1925, vol. xxiv, pp. 342-344.

TUMORS OF THE CÆCUM

- ⁴ Humiston, C E, and Piette, E C True Cholesteotoma of Cæcum J A M A, March, 1921, vol lxxxiv, pp 874-876
- ⁵ Joyce, T M Carcinoma of Cæcum S Clinic N America, October, 1924, vol iv, pp 1337-1338
- ⁶ Podalka, J Leiomyoma of Cæcum J A M A, Abstract, December 13, 1924, vol lxxviii, p 1962
- ⁷ Craig, McK W, and MacCarty Involvement of Lymph Glands in Cancer of Cæcum ANNALS OF SURGERY, June, 1923, vol lxxvii, pp 698-710
- ⁸ Piersol Human Anatomy, Lippincott, 7th Edition, 1919, vol 1, p 1660
- ⁹ Levy, I H, and Haft, H H Incidence of Cæcal Tuberculosis with Pulmonary Tuberculosis Amer Journ M Sc, July, 1922, vol clxiv, pp 115-123
- ¹⁰ Griffith, F W Actinomycosis of Cæcum Surg, Gyn & Obst, November, 1921, vol xxxiii, p 538
- ¹¹ Hinglais, M Adenomycosis of Cæcum and Appendix Intern Clinic, 1921, vol iii, p 59
- ¹² Hartwell, J A Non-tubercular Inflammation of Cæcum S Clinic N America, April, 1921, vol 1, p 361
- ¹³ Read, W D Tuberculosis of Cæcum Northwest Med, October, 1921, vol x, p 282
- ¹⁴ Ewing, J Neoplastic Diseases, 2d Edition, Saunders, 1922, p 661
- ¹⁵ Mayo, C H, and Hendricks, W A Carcinoma of Right Segment of Colon ANNALS OF SURGERY, March, 1926, vol lxxviii, p 357
- ¹⁶ Choyce, C C System of Surgery, Hoeber, 1923, vol 1, p 523
- ¹⁷ Parhan, D Colloid Carcinoma ANNALS OF SURGERY, 1923, vol lxxvii, pp 90-105
- ¹⁸ Menzies, C S Tuberculosis of Ileo-cæcal Region with Special Reference to the Cæcum Northwest Med, November, 1922, vol xxi, No 2, p 406
- ¹⁹ Coffey International Clinics, February, 1921, vol iv, Sec 31
- ²⁰ Mummery, J P L Diseases of the Colon, 1910, Wm Wood, p 322
- ²¹ Brown, L, and Samson, H L The Early Rontgen Diagnosis of Ulcerative Tuberculous Colics J A M A, July 12, 1919, vol lxxiii, pp 77-85
- ²² Archibald Amer Review of Tuberculosis, October, 1917, pp 433-449
- ²³ Read, W D Cæcal Pathology Northwest Med, January, 1921, vol x, No 1, p 11
- ²⁴ Erdmann, J F, and Carter, R F Malignancies of the Colon N Y Med Journ, June 7, 1922

THE ADVANTAGES OF A LOW MEDIAN-LINE INCISION IN EXPLORATORY LAPAROTOMY FOR CARCINOMA OF THE RECTUM OR RECTOSIGMOID*

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IN 1918 I presented before this association a paper recommending exploration of carcinomas of the rectum and rectosigmoid through a left rectus incision and the making of a colostomy through this incision similar in type to that previously described by Mixter. Since then this type of colostomy has been used many times in the Mayo Clinic and has been satisfactory in all except in one particular. However, following such an operation several patients developed intestinal obstruction caused by a loop of small intestine slipping down between the loop of sigmoid, which had been lifted up in performing the colostomy, and the left lateral wall of the abdomen.

In order to avoid this serious complication I have for some time explored growths in this region through a low median-line incision, and whenever colostomy was thought best I have performed it through a separate incision. Such an operation seems to have distinct advantages.

Through a low median-line incision it is easy to make a satisfactory examination of the abdominal cavity for evidence of metastasis in the liver, lymph-nodes, and other structures, and if one wishes, to perform primary resection, a Jones operation or a Coffey operation. Should a two-stage operation be preferable, as is often the case, a Mikulicz type of operation for growths in the sigmoid loop may easily be performed through the low median-line incision. If colostomy and subsequent posterior resection seem indicated, the loop of bowel selected for the colostomy may be carefully examined, and freed from any adhesions and then brought out by way of a separate incision through the abdominal wall, it may be placed at the point desired and close enough to the lateral abdominal wall to prevent the small intestines from slipping between them.

In such cases I have usually performed the colostomy through a guidon incision placed close to the crest of the ilium on the left side. With one hand in the abdominal cavity as a guide, one can quickly make an opening in the abdominal wall just large enough to permit the loop of bowel for the colostomy to be brought through (Fig 1). The loop brought out is supported by a strip of skin or a glass rod which is passed through an opening in its mesentery (Fig 2).

In some patients with growths in the upper rectum, but still above the peritoneum in the bottom of the cul-de-sac, we have made a temporary stoma of the sort mentioned and later resected the growth and made an end-to-end anastomosis and still later closed the stoma. If a temporary stoma is made,

* Read before the Southern Surgical Association, December 14, 1926

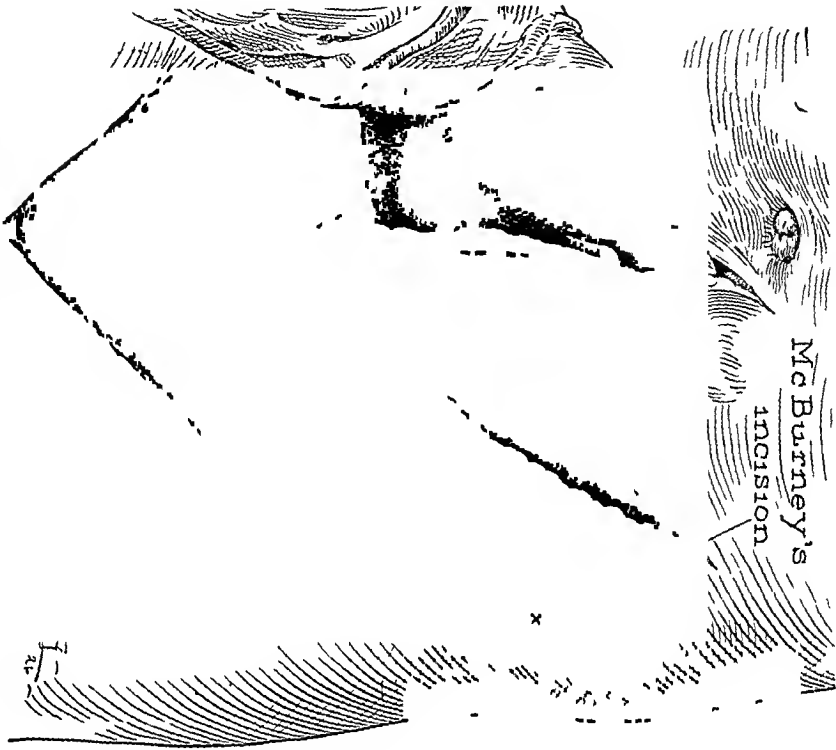


FIG 1.—Hand through median-line incision to elevate abdominal wall for a second incision (for colostomy)



FIG 2.—Median-line incision and loop brought out for colostomy

the limbs of the bowel may be sutured together as suggested by Coffey, and closed by applying clamps, and so forth, as is done in completing a Mikulicz type of operation (Fig 3)



FIG 3—Loop brought out through median-line incision for Mikulicz type of operation

It is necessary when performing colostomy to remember that the loop of bowel used should be brought out of the abdominal wall far enough to allow it to be cut completely across, otherwise the upper segment of bowel will often empty its contents into the lower one. In certain stout patients with thick abdominal walls the mesentery of the sigmoid is so short and wide that it is impossible to bring a knuckle of bowel entirely

through the abdominal wall without great tension, not only is colostomy performed under such circumstances dangerous, because of possible gangrene of the bowel from

tension, but the stoma often fails to function properly. In such cases I have found it much safer to extend the median-line incision upward an inch or two (Fig 4) and to make a stoma from a loop of the transverse colon. After the colostomy has been completed, the median-line incision may be closed and dressed separately from the colostomy wound. In practically all cases the wound from the incision heals primarily

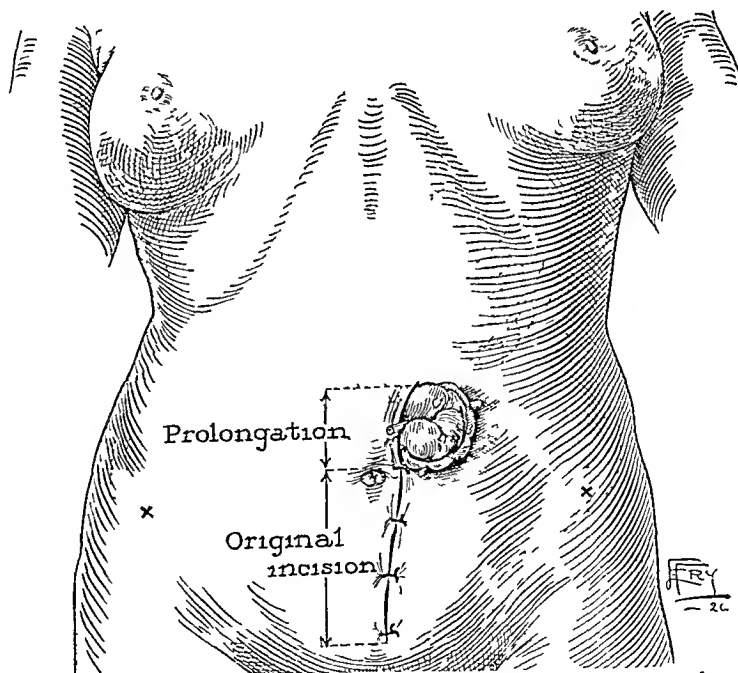


FIG 4—Median-line incision prolonged for colostomy in transverse colon

CLASSIFICATION OF RENAL AND URETERAL ANOMALIES¹

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OUR object is to attempt to classify in as complete a manner as possible all the various anomalies of the upper urinary tract. In place of a lengthy description, we prefer to illustrate the different groups in a diagrammatic way, and limit the description as much as it can be done.

We classify the anomalies as follows

A *Anomalies of the Kidneys*

1 *Anomalies of Number*

- a Solitary kidney (Figs 1 and 2)
- b Supernumerary kidney (Fig 3)

2 *Anomalies of Volume*

- a Hypoplasia (Fig 4)
- b Supplementary lobe (B of Fig 5) or hypertrophy (A of Fig 5)

3 *Anomalies of Form*

- Short, long, lobulated kidneys (Fig 6)

4 *Anomalies of Location*

- a Simple or ordinary unilateral ectopia (A of Fig 7)
- b Simple or ordinary bilateral ectopia (B of Fig 7)
- c Crossed ectopia with or without fusion (Figs 8 and 8A)

5 *Median Fusion*

- a Horseshoe kidney (Figs 10 and 11)
- b L-Shaped kidney (Fig 11)
- c Cake kidney (D of Fig 10)
- d Sigmoid kidney (C of Fig 11)

6 *Anomalies of Rotation*

- a Faulty rotation (A of Fig 12)
- b Excessive rotation (B and C of Fig 12)

7 *Reduplication of the Pelvis and Ureters* (Figs 13, 14, 15)

8 *Anomalies of the Pelvis* (other than reduplication) (Figs 16 and 17)

9 *Anomalies of the Vessels* (Figs 18, 19, 20)

- a Arteries (Figs 18 and 19)
- b Veins (Fig 20)

10 *Nonclassifiable Anomalies* (Fig 21)

B *Anomalies of the Ureters*

1 *Anomalies in Number* (See A 7) (Figs 13, 14 and 15)

2 *Anomalies of Calibre and Form*

- a Congenital strictures (Fig 22)
- b Congenital dilatation (Fig 23)
- c Valves (Fig 24)
- d Spiral twists and kinks (Fig 25)

¹ This is the first chapter of the monograph on Renal and Ureteral Anomalies to be published shortly

3 *Anomalies of Origin or Termination*

- a Abnormal modes of origin
 - b Ureterocele or cystic dilatation of lower end (Fig 26)
 - c Blind ending ureters (Fig 27)
 - d Ectopic ending of the lower end (Fig 28)
- 4 Diverticula of the ureter (Figs 29 and 30)

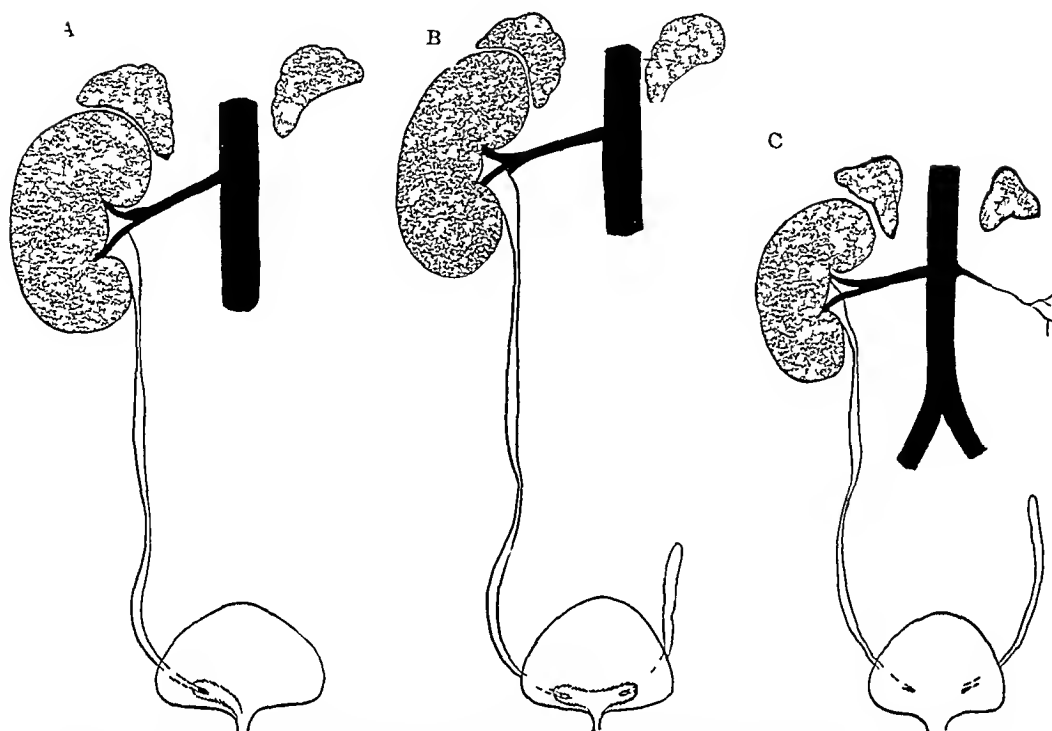


FIG 1 —A Absence of kidney ureter and ureteric orifice Asymmetric trigone B Absence of kidney but rudimentary ureter with normally placed and formed ureteric orifice and symmetric trigone C Same as B but with rudimentary renal artery

C *Combined Anomalies*

- 1 Double kidney and abnormal ending ureters (Fig 31)
- 2 Double and horseshoe kidney (Fig 32)
- 3 Vascular anomalies and renal anomalies
- 4 Ectopia and horseshoe kidney (Fig 33)
- 5 Hypoplasia and double kidney
- 6 Hypoplasia and horseshoe kidney

D *Concomitant Anomalies* (Fig 34)

- a Of urinary tract
- b Of genital tract
- c Of other structures

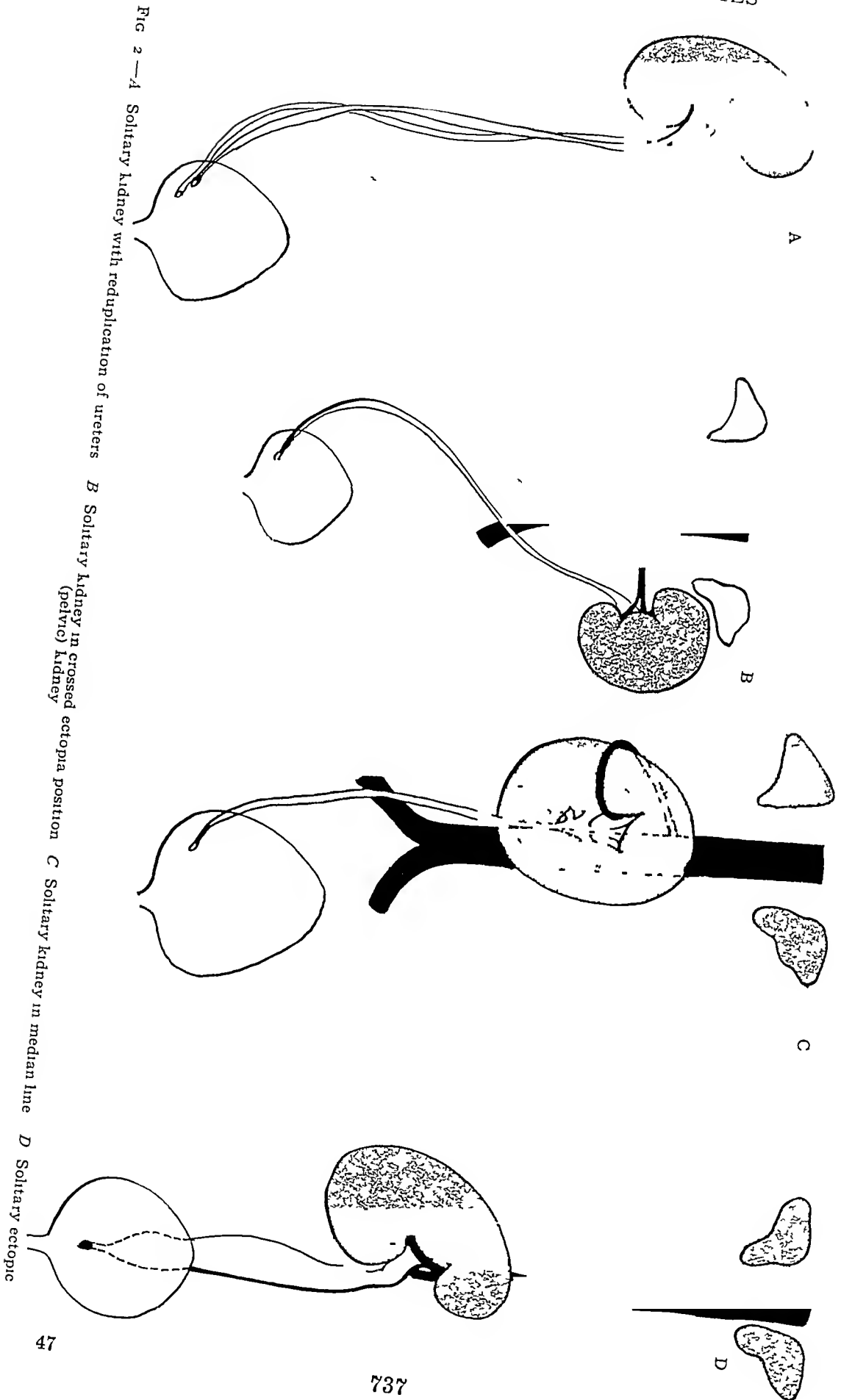
Let us consider these a little in detail

A I ANOMALIES OF NUMBER OF KIDNEYS

We will omit bilateral absence of the kidneys, which is a monstrosity incompatible with life

The number of kidneys can either be decreased or be in excess

(a) *By Default (Absence)* —Under this heading should be placed the congenital solitary kidney The term should only be employed when there



are no traces of the opposite kidney. Congenital agenesis or aplasia are synonymous with congenital solitary kidney. One should not confuse the condition with unilateral fusion of two kidneys each having a ureter which ends at opposite ends of the trigone. The term crossed ectopia is a more correct one to apply to such an anomaly (Fig 8)

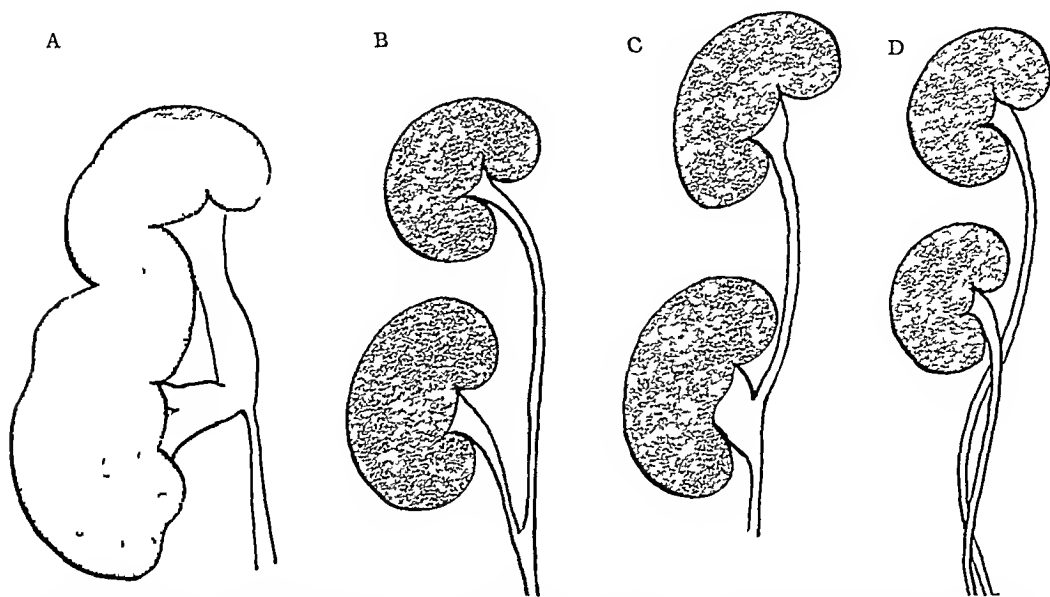


FIG 3—Reduplication and supernumerary kidney. A Reduplication of pelvis alone with partly divided kidney. B Reduplication (incomplete) of ureter and completely separated kidneys. C Reduplication (complete) of ureter and completely separated kidneys. D Reduplication (complete) of ureter and completely separated kidneys. C Most common form of supernumerary kidney. Upper ureter empties into lower pelvis or ureter of lower (supernumerary) kidney.

There are three principal types of solitary kidney:

1 With symmetric or asymmetric trigone (A of Fig 1). No trace of opposite kidney or ureter.

2 With symmetric trigone, two ureteral orifices and a ureter on the agenesis side which is of variable length (B of Fig 1).

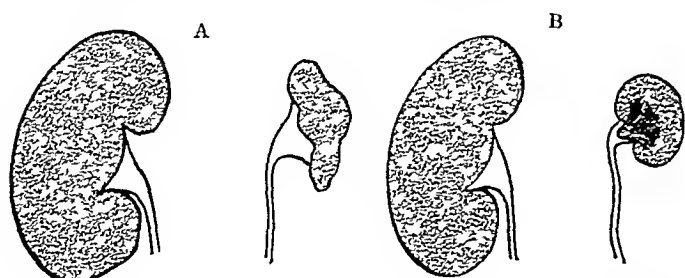


FIG 4—A Congenital hypoplasia or atrophy. B Congenital hypoplasia with single papilla.

3 With more or less developed ureter on the agenesis side and rudimentary renal vessels (C of Fig 1).

The solitary kidney may be of normal or of increased volume. The adrenal on the agenesis

side is either in its normal location or ectopic. One may encounter some atypical conditions, such as:

1 Solitary kidney with two ureters ending side by side in the bladder (A of Fig 2).

2 Solitary kidney in crossed ectopia (B of Fig 2).

3 Solitary kidney in median ectopia (C of Fig 2).

4 Solitary kidney and pelvic ectopia (D of Fig 2).

RENAL AND URETERAL ANOMALIES

b *Multiple Kidneys, i.e., Excess (Supernumerary)*—These are rare and one must consider four forms

1 Pseudo-double kidney, i.e., single mass of parenchyma but two pelves and a single ureter (A of Fig 3)

2 Two kidneys with two ureters uniting to form a single ureter (B of Fig 3)

3 Same as above but the two ureters open separately into bladder (D of Fig 3)

4 Two kidneys but ureter of upper opens into lower (C of Fig 3)

(Most common form of supernumerary kidney)

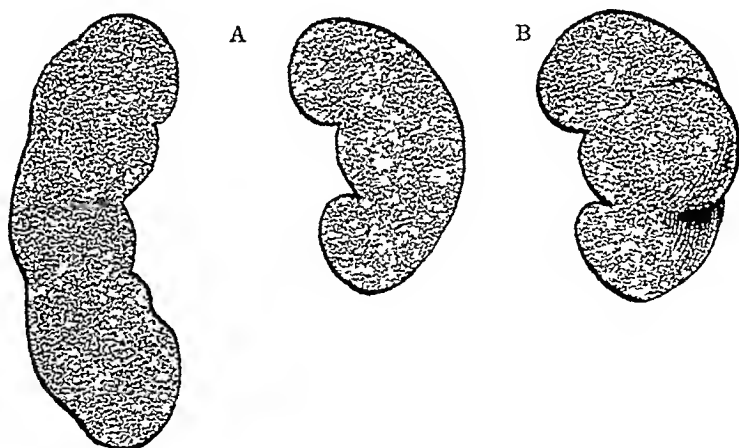


FIG 5—A, Congenital hypertrophy of one kidney B, Supplementary anterior lobe

Numbers 1, 2, and 3 are rare and the only published cases are unilateral

A 2 ANOMALIES OF VOLUME

(a) *Congenital Atrophy or Hypoplasia*—The two normal kidneys are seldom of the same weight or volume. The ureter of an atrophic kidney is usually patent. It can be dilated or obliterated either at its upper or lower end, or at portions of its course, or in its entirety.

(b) *Congenital Hypertrophy*—The kidney can be hypertrophied compensatorily because the opposite one is atrophic, but it can also be enormous while the opposite one is normal, as in Papin's (A of Fig 5) case.

(c) *Supplementary Lobes*—In Papin's case this formed a marked pro-

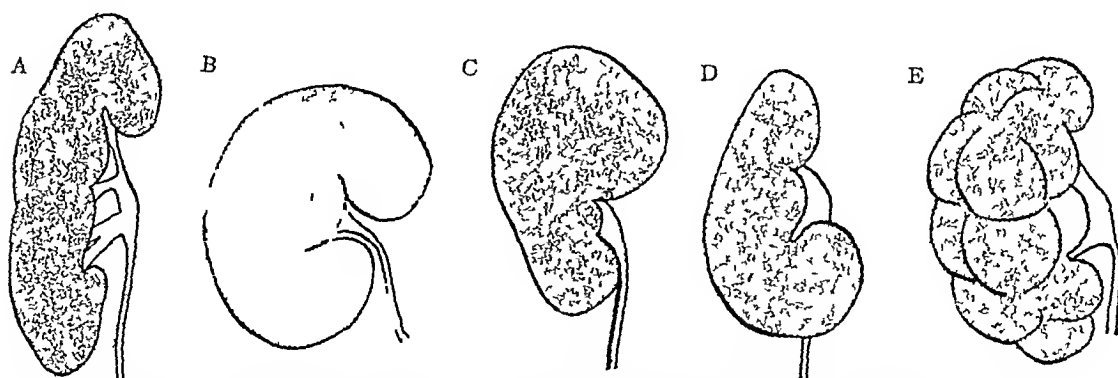


FIG 6—A Long kidney with wide pedicle B Short kidney with deep hilus C Kidney with large upper half D Kidney with large lower half E Kidney with fetal lobulation

trusion (B, Fig 5) on the anterior surface. On section one found one pyramid and a corresponding calyx directed sagittally.

A 3 ANOMALIES OF FORM OF KIDNEYS

There are many variations in form, thus

(a) Long kidney with wide pedicle (A of Fig 6)

(b) Short kidney with closed hilus (B of Fig 6)

- (c) With large upper half (C of Fig 6)
- (d) With large lower half (D of Fig 6)
- (e) With fetal lobulation (E of Fig 6)

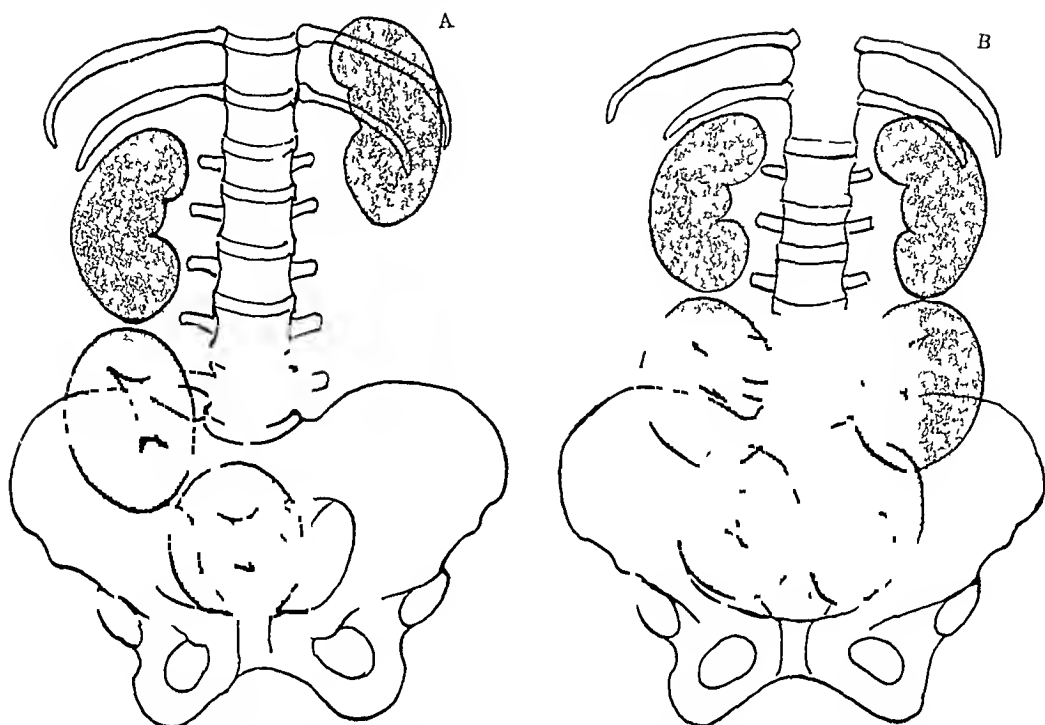


FIG 7 —A Simple or ordinary (unilateral) ectopia lumbar iliac pelvic B Simple or ordinary (bilateral) ectopia iliac pelvic

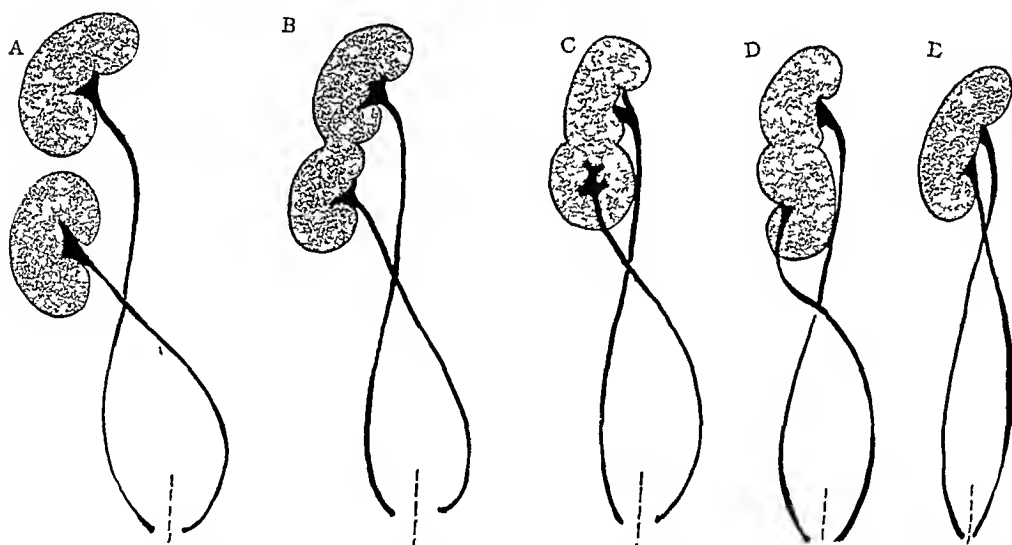


FIG 8 —Crossed ectopia A Completely separated kidneys B Fusion of both kidneys (to right or left of midline as indicated by vertical dotted line) C Hilus of lower of the two incompletely fused kidneys faces ventrally D Same as C but lower hilus faces laterally E Complete fusion of the two kidneys

A 4 ANOMALIES OF POSITION OF KIDNEYS

I The kidney can be found in an abnormal location either by arrest or faulty development. One must differentiate them from the kidneys whose abnormal location is of acquired origin. Ectopia can be lumbar, iliac or pelvic

RENAL AND URETERAL ANOMALIES

(Fig 7, A) or it can be unilateral or bilateral (Fig 7, B) The last named may be symmetric or asymmetric in position All such ectopias are called homolateral

2 Heterolateral or crossed ectopias are where one of the two kidneys has crossed the midline to reach the opposite side There are three forms

(a) The kidneys are not fused (A of Fig 8)

(b) The kidneys are fused but the line of fusion is still distinct The lower of the two may have its pelvis directed mesially (B of Fig 8), ventrally (C of Fig 8) or laterally (C of Fig 8)

(c) The two are fused so that there is no external sign of such fusion (E of Fig 8) As a rule it is the lower of the two which is ectopic, but in some it is the upper (F of Fig 8) The case of Lichtenstein of bilateral crossed ectopia (G of Fig 8) is open to question

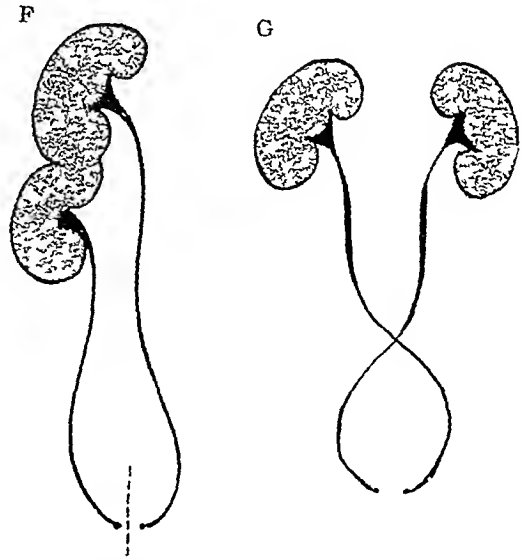


FIG 8—F Unusual condition in which the ectopic kidney which belongs to opposite side of body lies above the normally migrated kidney G Unusual condition in which right kidney has crossed over to left side of body and vice versa

A 5 MEDIAN FUSION

We include in this group all cases in which there is a union of the two

kidneys to a greater or lesser extent at their mesial borders As long as one-half extends beyond the midline of the spine, the anomaly belongs in this group When, however, both halves lie entirely either to the right or left of the midline of the spine, the anomaly is better classified as a crossed ectopia (Fig 8) The true cases of median fusion therefore include other cases than those usually referred to as horseshoe kidneys In the latter the degree of median line fusion varies from a nar-



FIG 9—To show difference between an abnormally mobile (dropped) and a congenitally (simple or ordinary) ectopic kidney In the former the vessels arise (1) at the normal level while in latter (B) they arise from the immediately adjacent vessels

row fibrous or parenchymatous bridge to complete fusion along the mesial borders, i.e., a cake-kidney. Cases, however, of L-shaped or S-shaped (sigmoid) kidneys in which one-half extends beyond the midline should be equally as well classified under the heading "Median Fusion." All such anomalies lie much lower than the normally formed and placed kidneys. Their

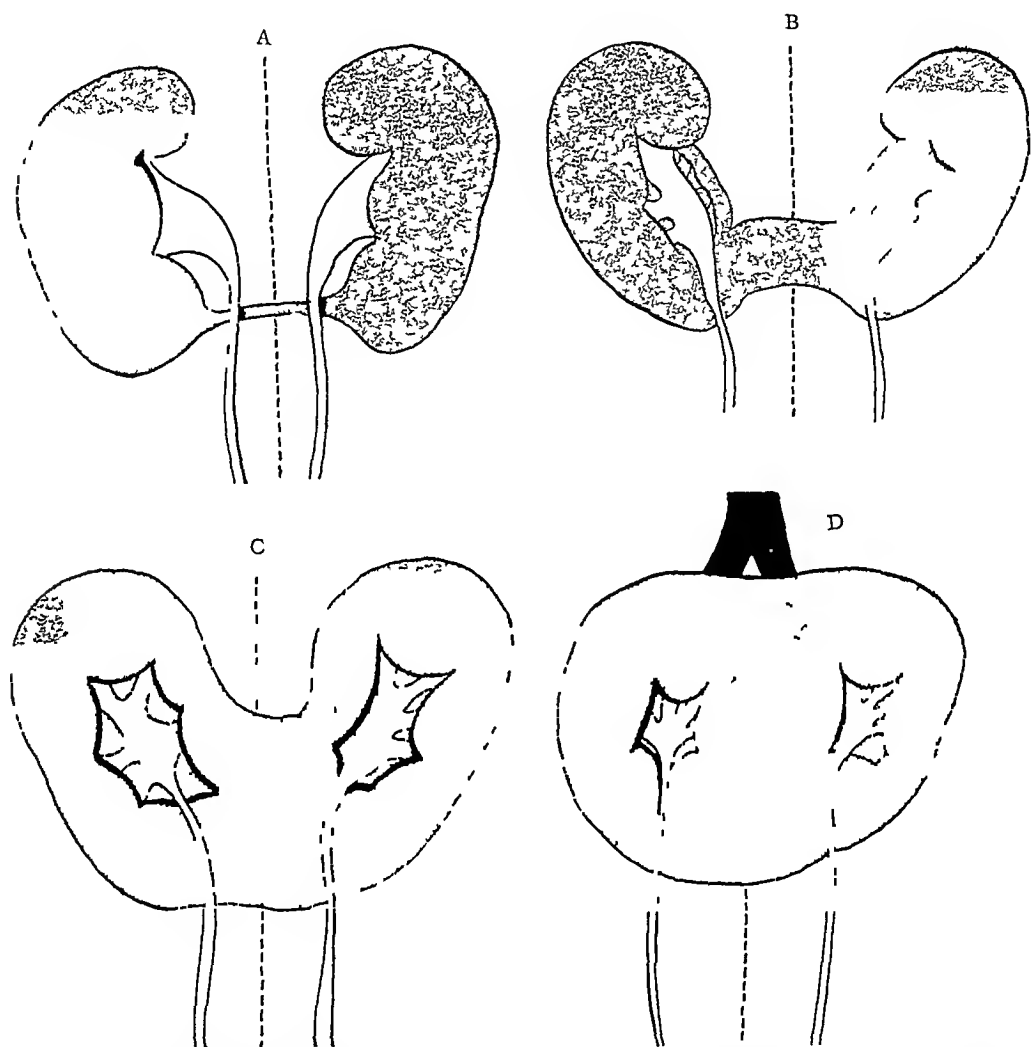


FIG. 10—Horseshoe kidneys with inferior isthmus (90 per cent of all cases). A With very narrow isthmus. B With isthmus of average (4–5 cm) width. C With very wide isthmus. D With isthmus so wide that there is no line of demarcation between the two halves (the so called cake kidney).

pelves, however, are on the ventral aspect, a point of much importance from a diagnostic standpoint. We may, therefore, find the following forms:

1. Fusion of two of the poles

(a) Inferior (narrow, median and wide isthmus) (A, B and C of Fig. 10)

(b) Completely along the mesial border (D of Fig. 10) (cake kidney)

(c) Superior isthmus (A of Fig. 11)

2. Sigmoid (C of Fig. 11), one in normal location and the other attached to lower pole of first one

3. One remains higher than the other (L-shaped) (B of Fig. 11)

RENAL AND URETERAL ANOMALIES

A 6 ANOMALIES OF ROTATION OF KIDNEYS

(a) Incomplete—kidney faces ventrally, it is flattened and pelvis is at middle of anterior surface, vessels cross the front to reach the hilus and the ureter descends in front of kidney (A of Fig 12)

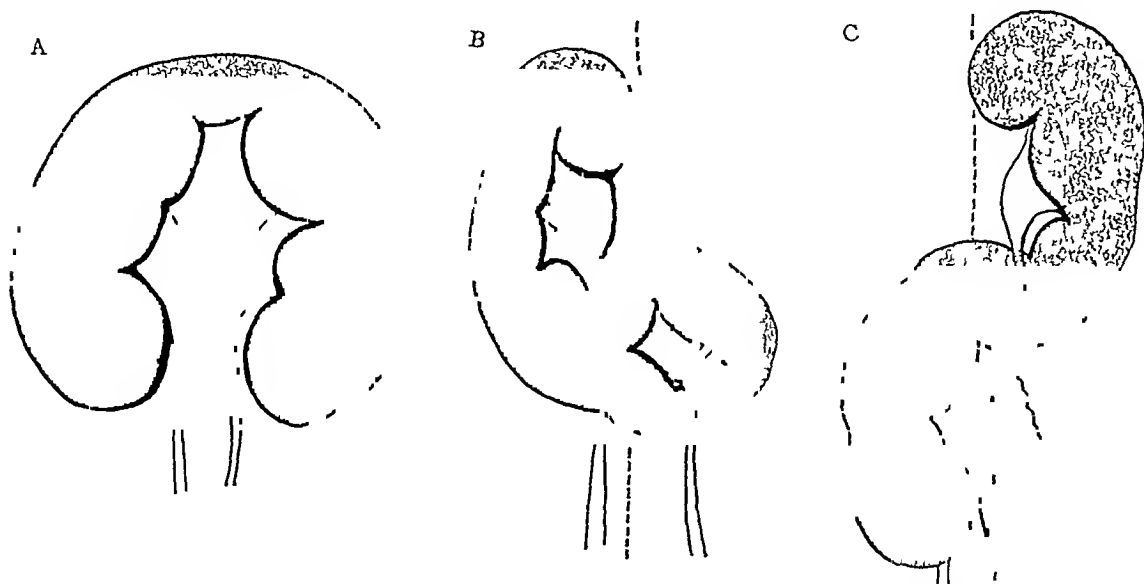


FIG 11 —Unusual types of horseshoe kidneys. A With isthmus at upper poles (10 per cent of all cases) B L-shaped horseshoe kidney C Sigmoid form with pelvises facing laterally Differs from crossed ectopia (Fig 9) by fact that the halves extend to both sides of midline

(b) Excessive rotation Hilus on dorsal aspect and latter is crossed by vessels to reach hilus (B of Fig 12)

(c) The convex border is mesial and pelvis faces laterally (C of Fig 12)

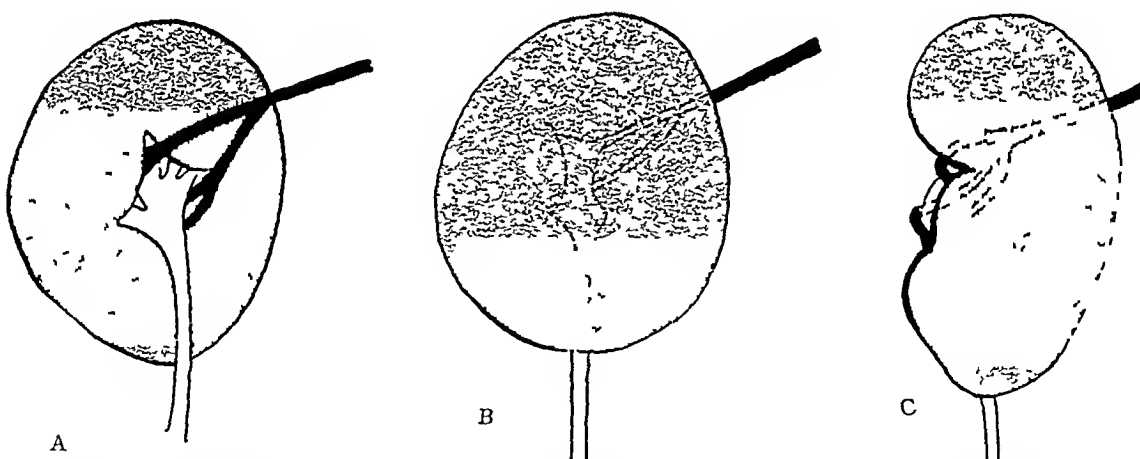


FIG 12 —Most frequent types of faulty rotation of the kidney (renal torsion) A Incomplete rotation with hilus on ventral aspect B Excessive rotation with hilus on posterior aspect C Excessive rotation with hilus facing laterally

The vessels cross the dorsal aspect and the ureter descends along lateral border

A 7 REDUPLICATION OF THE PELVES AND URETERS (DOUBLE KIDNEY) (FIGS 13, 14 AND 15)

Under normal conditions the ureter divides into two major calyces with or without a pelvis proper. An early division may occur, *i.e.*, one just external to the hilus. The kidney then has two pelvises, an upper and a lower

(b) An ampullary pelvis into which the minor, *i.e.*, secondary calyces empty without intervening major calyces (B of Fig 16)

(c) A bifid type (hemibassinet of Hyrtl) One of the major calyces (the inferior) is dilated and ampullary while the other has a number of calyces (C of Fig 16)

The true anomalies include the following

(a) Congenital dilatation, *i.e.*, congenital hydronephrosis or megalo-pelvis without stricture at the ureteropelvic junction (A of Fig 17)

(b) The extraarenal pelvis (B of Fig 17) Both the pelvis proper and most if not all of the major calyces are extraarenal, *i.e.*, lie distal to the hilus of the kidney

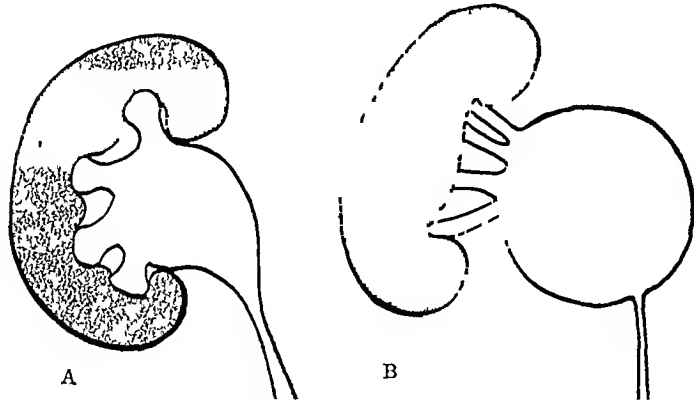


FIG 17—A Congenital hydronephrosis without ureteral or other distal obstruction B Pelvis and major calyces entirely extraarenal

A 9 ANOMALIES OF THE VESSELS OF THE KIDNEYS

1 *Arteries*—These are very common (see Figs 18 and 19) Under normal conditions there is a single artery arising from the aorta and dividing in variable manner into three terminal branches, pre- and retro-pelvic and superior polar. The anomalies may be grouped as follows

(a) Of number—from one to six arteries have been noted

(b) Of origin—aorta, spermatic, common iliac, external and internal iliac

(c) Of course—in front and behind aorta and vena cava

(d) Of penetration—hilus, pole, front borders Of particular interest are the polar arteries. The superior polar can arise from the renal or aorta. The inferior polar can arise from the renal, aorta, common or external iliac. The inferior polar may cross

in front or behind the ureter and may cause or aggravate a hydronephrosis

2 *Veins*—Among the more important anomalies one finds (see Fig 20)

(a) Presence of a left inferior vena cava

(b) Retro-colic venous anastomosis

(c) Superior polar

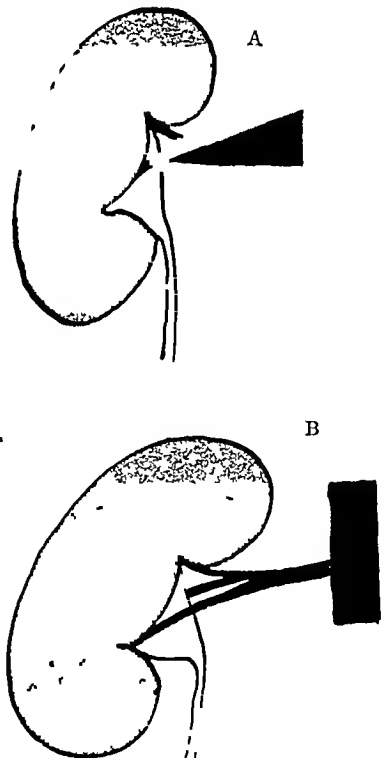


FIG 18—Types of renal arteries
A Division before reaching renal hilus
B Two separate renal arteries

RENAL AND URETERAL ANOMALIES

(d) Inferior polar—more common and can arise from the vena cava, renal vein and iliac vein

(e) Renal vein entirely retroperic

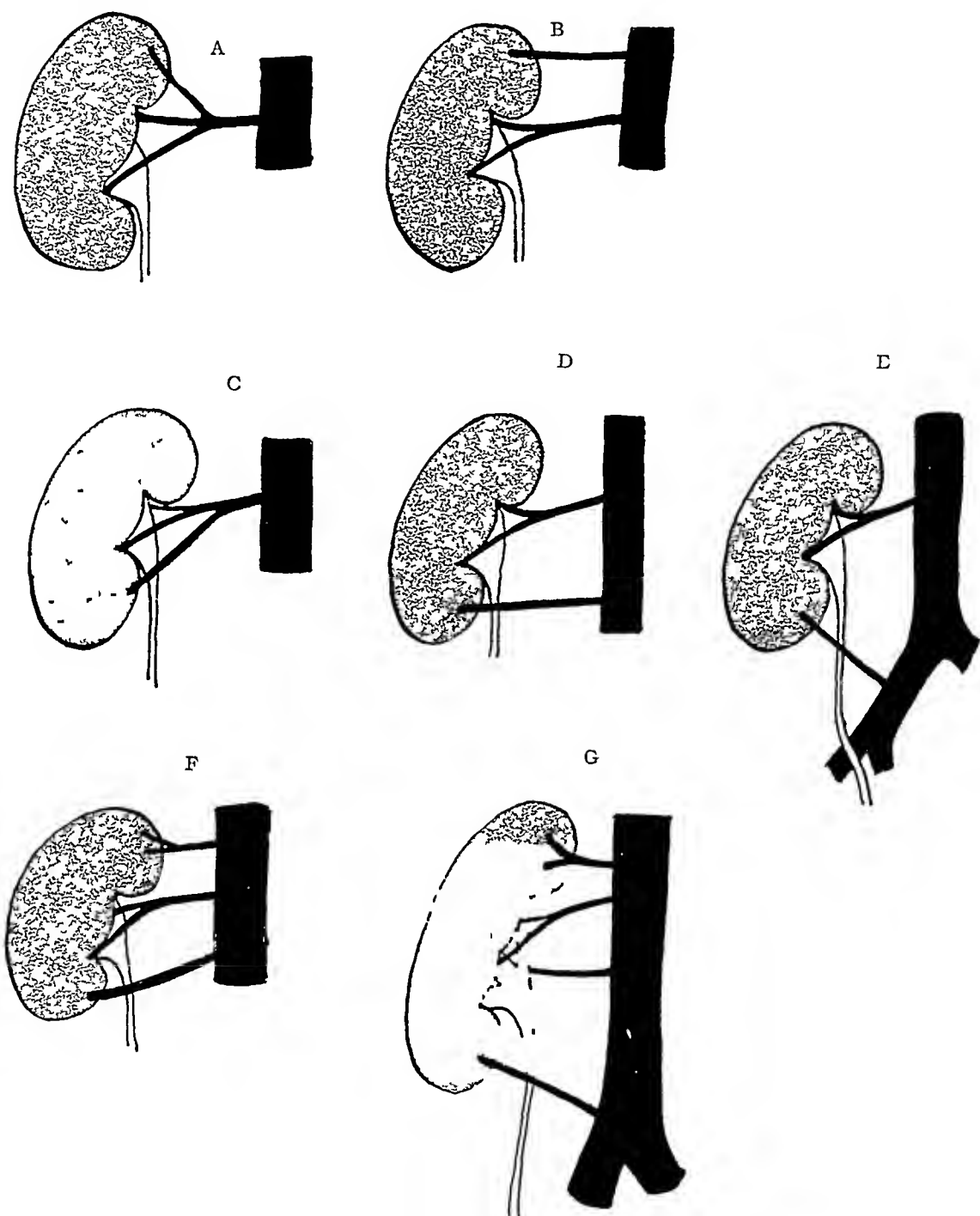


FIG 19—Anomalous (accessory) polar arteries. *A* Superior polar arising from main renal artery. *B* Superior polar artery arising from aorta. *C* Inferior polar artery arising from main renal. *D* Same arising directly from aorta. *E* Same arising from common iliac artery. *F* Main renal artery to hilum and superior and inferior (also from aorta) arteries to upper and lower poles respectively. *G* Same as *F*, but separate (fourth) artery to back of pelvis.

A 10 NON-CLASSIFIABLE ANOMALIES (FIG 21)

Under this heading one must place the cases of Hepburn and Braasch. The ureters of the two normally placed kidneys unite and end at one angle of the trigone.

B ANOMALIES OF THE URETERS

B 1 Anomalies of Number—These are described under reduplication of the renal pelvis (see A 7), because such a condition is never found without reduplication of the ureters to a greater or lesser degree

B 2 Anomalies of Caliber and Form—The ureter normally presents a

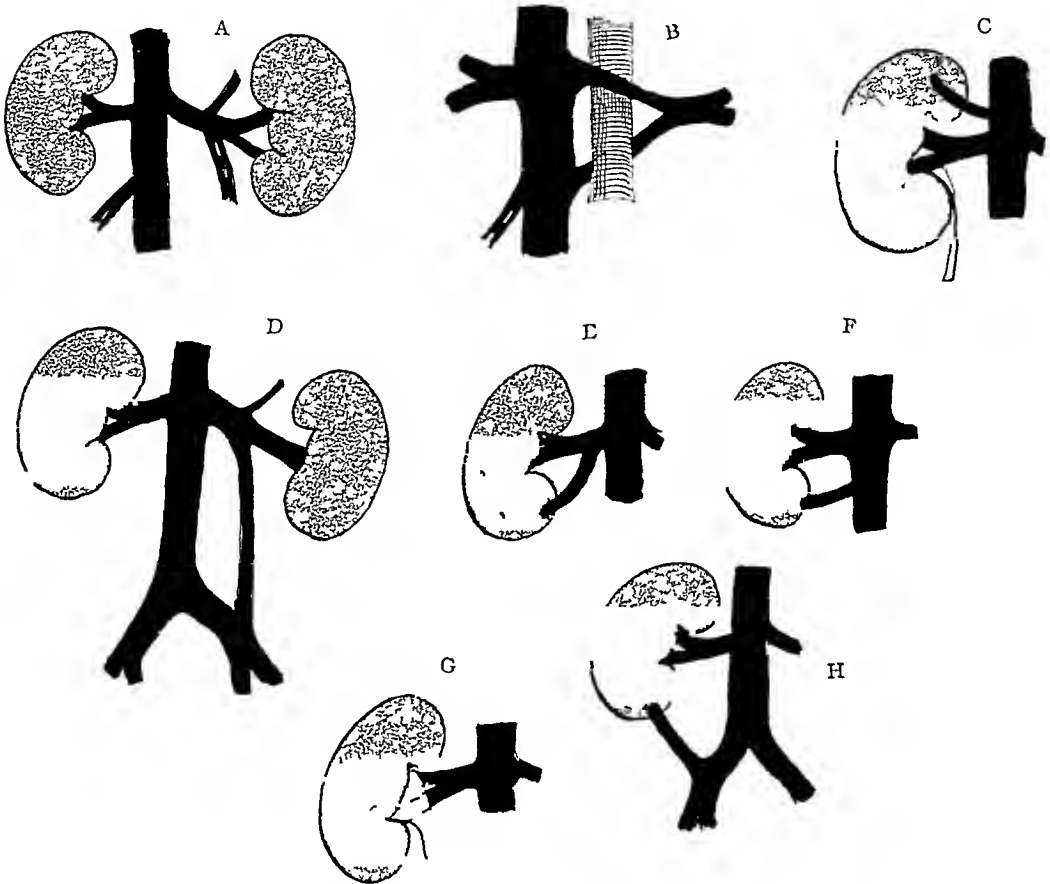


FIG. 20.—Anomalous (accessory) polar veins. A Normal renal veins to each hilus. B Double vena cava. C Venous ring surrounding aorta. D Superior polar vein from vena cava. E Inferior polar vein from main renal vein. F Inferior polar vein from vena cava. G Inferior polar vein from common iliac vein. H Main renal veins pass behind instead of in front of the pelvis.

series of dilatations separated by narrowings. These are from above downward the following:

- (a) The ureteropelvic funnel or junction (B of Fig. 22)
- (b) The narrowing just below the preceding
- (c) The lumbar dilatation or "spindle"
- (d) The iliac narrowing (where ureter crosses iliac vessels)
- (e) The pelvic dilatation or "spindle"
- (f) The juxtavesical narrowing which passes imperceptibly into
- (g) The intramural segment and ureteral orifice

There may be considerable variation, *i. e.*, a certain number of narrowings or of spindles may be absent so that the lumbar and pelvic "spindles" are continuous (A of Fig. 22).

The true anomalies are

RENAL AND URETERAL ANOMALIES

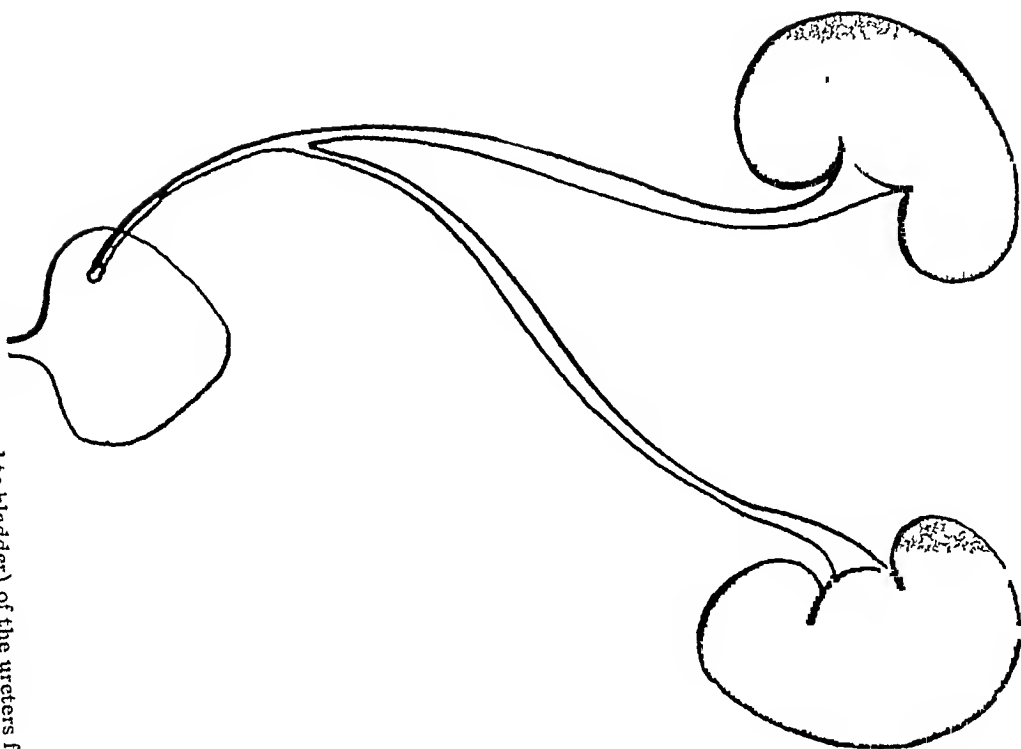


FIG 21.—Unilateral fusion (proximal to bladder) of the ureters from both kidneys. Only two such cases reported (see text)

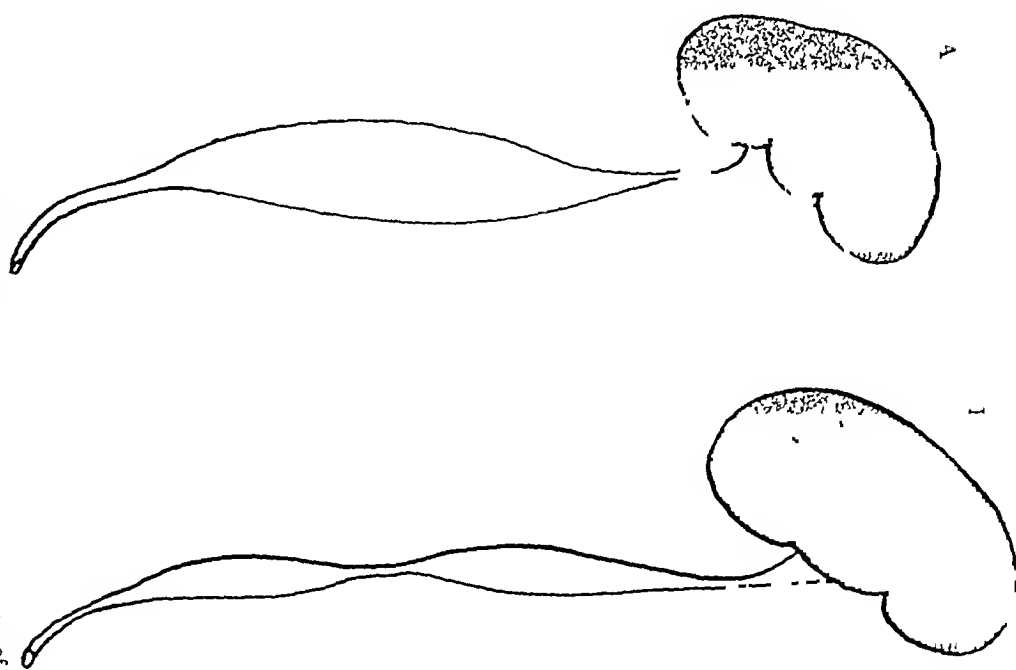


FIG 22.—To show 'spindles' and narrowings of the normal ureter. A. Single spindle instead of two as in A'. B. To show lumbar and pelvic spindles.

A Congenital Strictures—These usually occur at the points of narrowing (A of Fig 22), but can be found anywhere in the lumen of the ureter

B Congenital Dilatations (Fig 23)—These can be (a) total (C of Fig 23), including the entire ureter and its vesical orifice, (b) subtotal (B of Fig 23)—all of the ureter except its vesical orifice and (c) partial, *i e* forming a series of spindles as in A of Fig 23

The dilatation may be of such a degree that the ureter resembles a coil of intestine

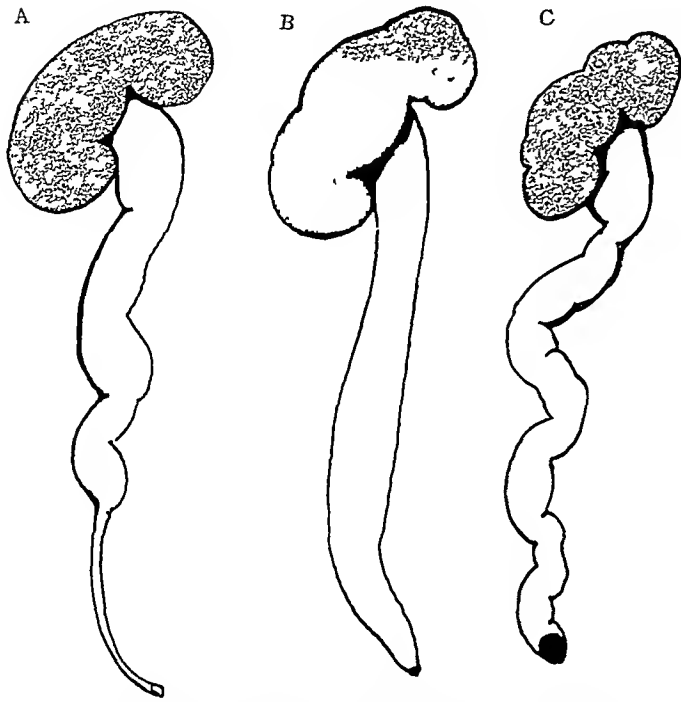


FIG 23 —To show congenital ureteral dilatation A Partial dilatation B Subtotal dilatation C Total (complete) dilatation

C Valves (Fig 24)—These are found at both ends of the ureter, *i e*, near the renal pelvis or the vesical outlet They are most commonly seen in the foetus or in the new-born

D Spinal Twists and Kinks—The former involve the entire lumen, the tube appearing to be twisted upon itself (Fig 25) Kinks usually are found in connection with faulty modes of origin of the ureter from the renal pelvis They may, however, be found at any level,

often as the result of either abnormal mobility of the kidney or redundancy, *i e*, excessive length of the ureter

B 3 ANOMALIES OF ORIGIN AND ENDINGS

(a) *Anomalies of Origin*—In this group the ureter instead of arising from the funnel-like ending of the renal pelvis (A of Fig 22) begins at a higher point so that as the pelvis fills, it compresses the ureter and gradually more and more of a pouch forms below the ureteral outlet Rarely, as in Manasse's case, the ureter passes entirely around the top of the pelvis before proceeding toward the bladder

(b) *Ureterocele* (cystic dilatation of lower end of ureter)—Under this heading is included a dilatation of that portion of the ureter just proximal to the ureteral (vesical) orifice It is usually the result of a narrowing less often a complete closure of the vesical orifice Although in its early stages it presents (A of Fig 26) as a cherry-sized swelling, it may attain an enormous size (B of Fig 26) and occlude the opening of the opposite ureter or become incarcerated in the urethra (C of Fig 26) or prolapse through the



FIG 24—Location of ureteral valves

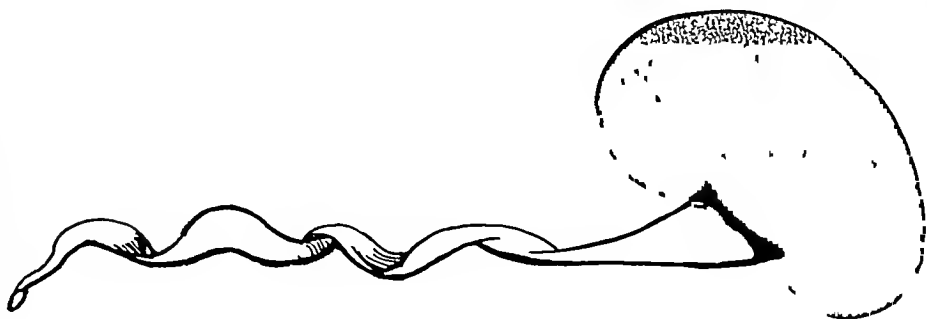


FIG 25—Spiral twist (torsion) of the ureter

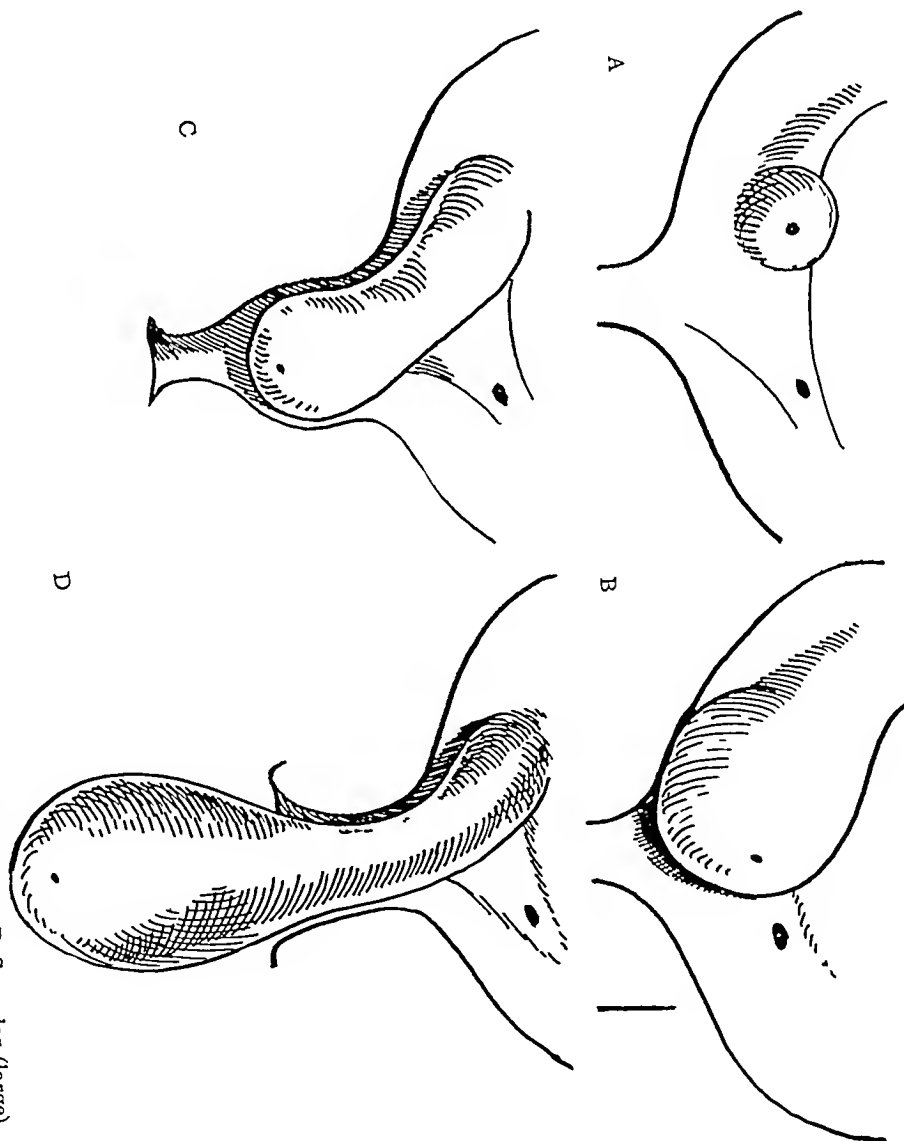


FIG 26—Various forms of ureteroceles (cystic dilatation) A Small ampullary B Saccular (large) C, Prolapse into urethra (usually female) D, Prolapse through urethra (complete)

external meatus and present externally (D of Fig 26) Such a prolapse usually occurs in the female

(c) *Blind Ending Ureters*—These present in two forms, usually as an accompaniment of reduplication of the ureters

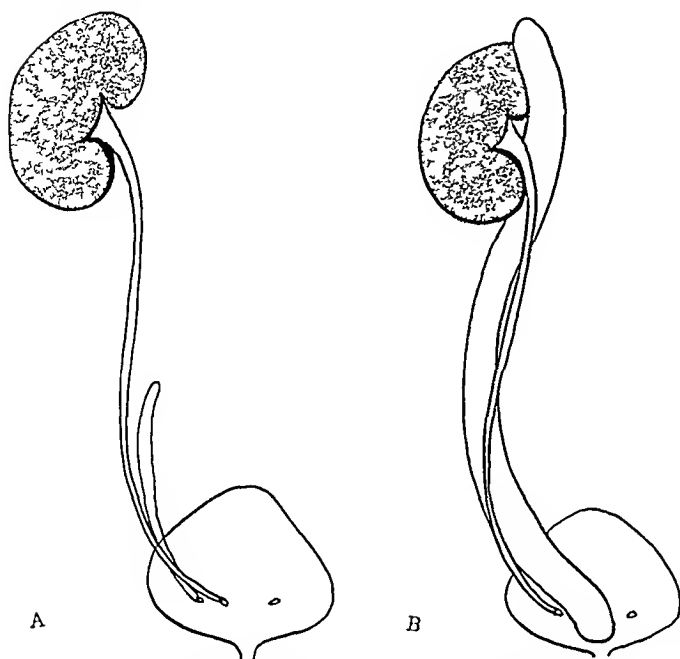


FIG 27—Blind ending ureters. A Blind ending rudimentary ureter. B Completely developed blind ending ureter

In one form (A of Fig 27) the second ureter is rudimentary and ends blindly above only In the other form (B of Fig 27) the second ureter ends blindly above and below At times there is a hypoplastic half of a double kidney developed around a second ureter which ends blindly below

(d) *Abnormal Ectopic Endings of the Ureters* (Fig 28) —Although this

may occur in the case of a kidney having but one ureter, it is usually found in double kidneys, *i e*, reduplication of the ureters and renal pelves One of the two ureters (usually the one ending more dis-

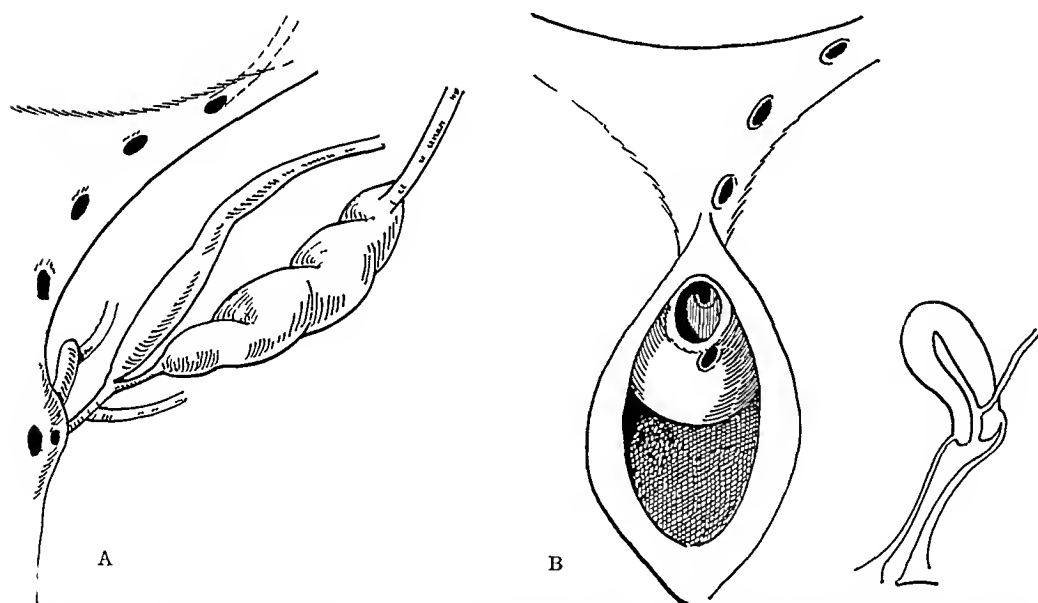


FIG 28—A Abnormal (ectopic) ureteral endings in the male. From above downward note the possible endings in the bladder prostatic urethra utericle ejaculatory duct and seminal vesicle. B Abnormal (ectopic) ureteral endings in the female. Note possible endings in the bladder urethra at the meatus (external) vagina and uterus (seen in sagittal section)

tally) opens either at some point considerably below the opening of the ureter from the other half or it opens extravasically The anomaly can be uni- or

RENAL AND URETERAL ANOMALIES

Fig 29—Various types of single diverticula of ureter
A Ampullary diverticulum *B* Diverticulum ending in fibrous prolongation

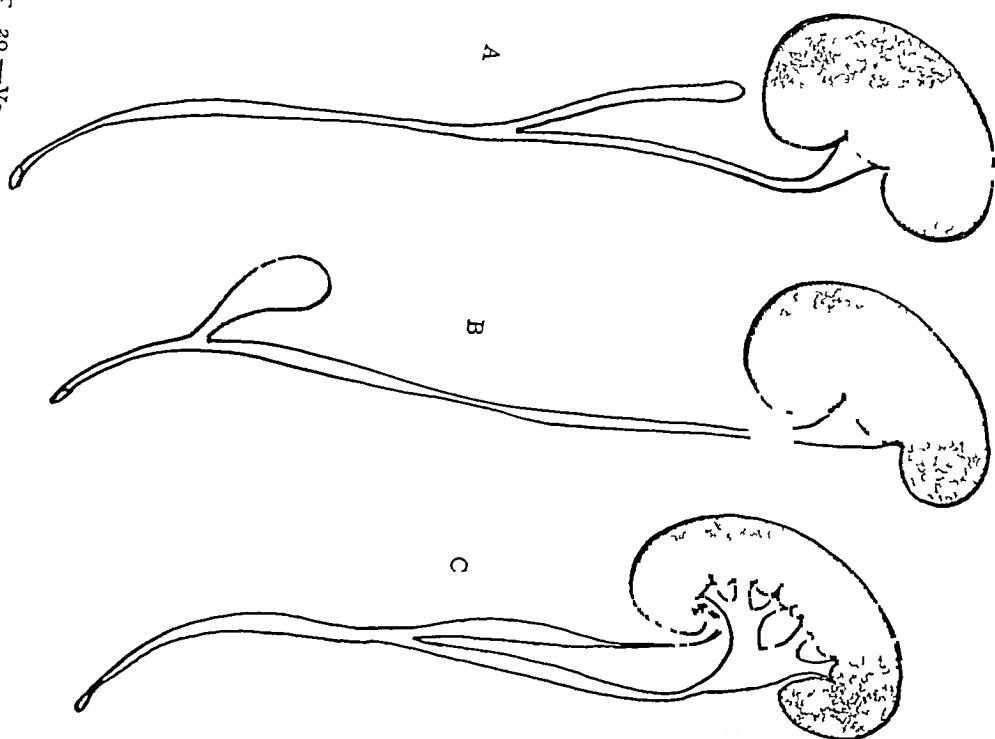


Fig 30—Multiple diverticula (Pepper's case)

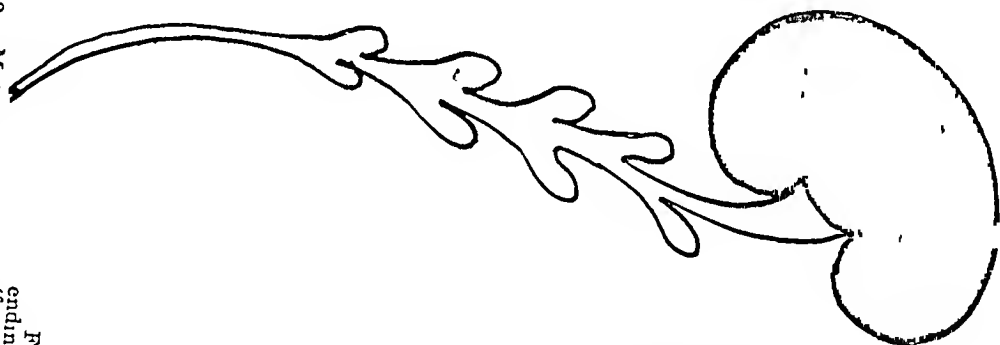
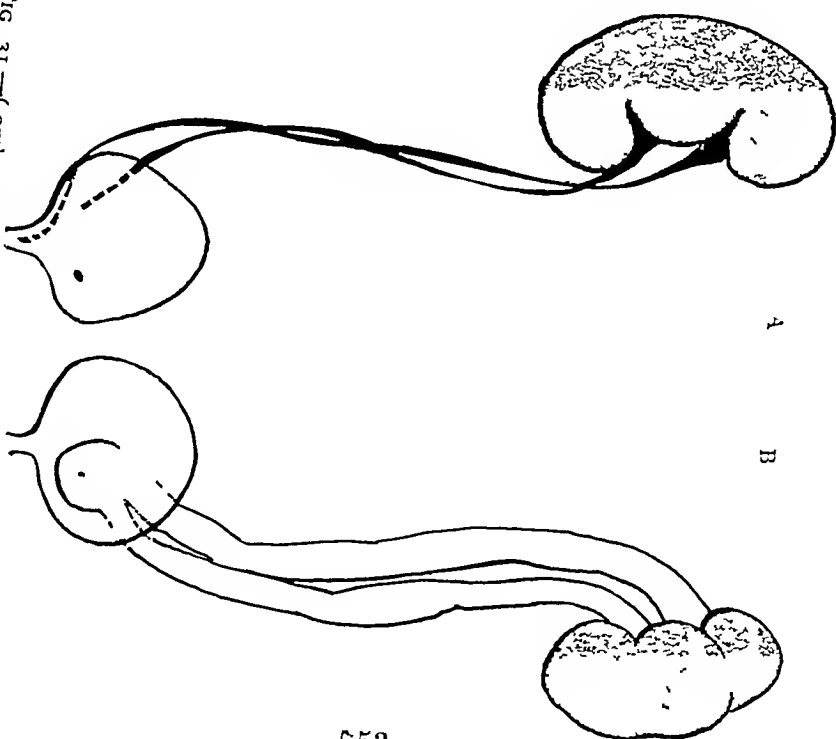


Fig 31—Combination of double kidney and ectopic ureteral ending
A Complete reduplication of ureters and pelvis. One ureter ends in urethra. *A* frequent finding but the other (from upper half) ectopic ureteral ending *B* Both ureters of a double kidney end in a cystic dilatation



bilateral both in the case of the ureter of a normal (single pelvis) kidney as well as in that of a reduplication of the pelves and ureters

In the intravesical cases of abnormal ending the latter can be found anywhere between the location of the normal orifice and the internal meatus (Fig 28) The location of the extravesical openings vary according to the sex of the individual In males it can be located in the prostatic urethra up to the verumontanum, in the prostatic utricle, ejaculatory duct or seminal vesicle (A of Fig 28) In females, the ureter can open in any portion of

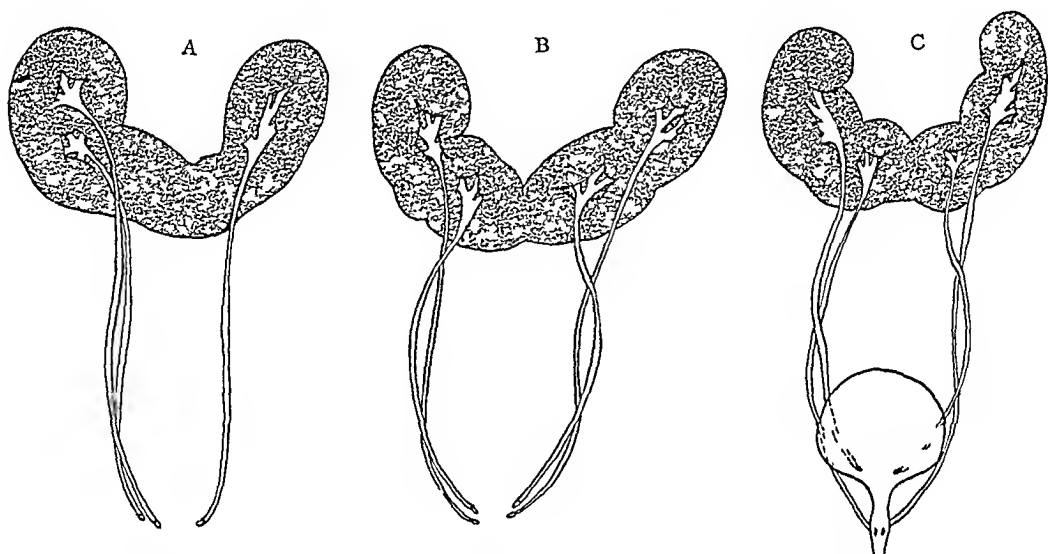


FIG 32 —Combination of horseshoe and double kidney A Complete reduplication of renal pelvises and ureters on one side only B Same on both sides C Same as B but one ureter on each side ends ectopically (in urethra)

the urethra, at the external meatus, vulva, anterior vaginal wall or neck of the uterus (B of Fig 28)

(e) *Diverticula of the Ureter* —One can find reports of cases of simple diverticula with blind upper end (A of Fig 29) of ampulla-like diverticula (B of Fig 29) or a termination in a long fibrous cord (C of Fig 29) and finally as in Pepere's case of multiple diverticula (Fig 30)

C COMBINED ANOMALIES

Almost any combination of the principal types of both renal and ureteral anomalies may occur We will only attempt to name the more common ones

C 1 *Congenital Solitary Kidney* —(a) The presence of a solitary kidney in the normal renal location and of a rudimentary ureter on the opposite side (B of Fig 1)

(b) The association of solitary kidney with ectopia (D of Fig 2)

(c) The presence of the solitary kidney (crossed ectopia) on the side of the body opposite to that on which its ureter ends (B of Fig 2)

C 2 *Hypoplasia* —(a) The association of hypoplasia of one kidney with a double kidney on the opposite side

RENAL AND URETERAL ANOMALIES

(b) The abnormal ending of the ureter of a hypoplastic kidney, *i.e.*, either blindly or in the urethra, seminal vesicle (Fig 28), etc

(c) Hypoplasia of one-half of a horseshoe kidney

C 3 Horseshoe Kidney—(a) The presence of reduplication of the ureters and renal pelves in one or both halves of the horseshoe kidney (Fig 32).

(b) Ectopia (simple) cake (one of varieties of horseshoe kidney) kidney (D of Fig 10)

(c) Combination of ectopic ending of the ureter of one-half of a horseshoe kidney

(d) Association of hypoplasia and horseshoe kidney

C 4 Double Kidney—(a) Association of double and horseshoe kidney (Fig 32)

(b) Ectopic ending of ureter of one-half of double kidney on one or both sides (A of Fig 31)

(c) Blind ending or termination in a ureterocele of one or both ureters of a double kidney on one or both sides (B of Fig 31)

(d) Hypoplasia of one-half of a double kidney on one or both sides

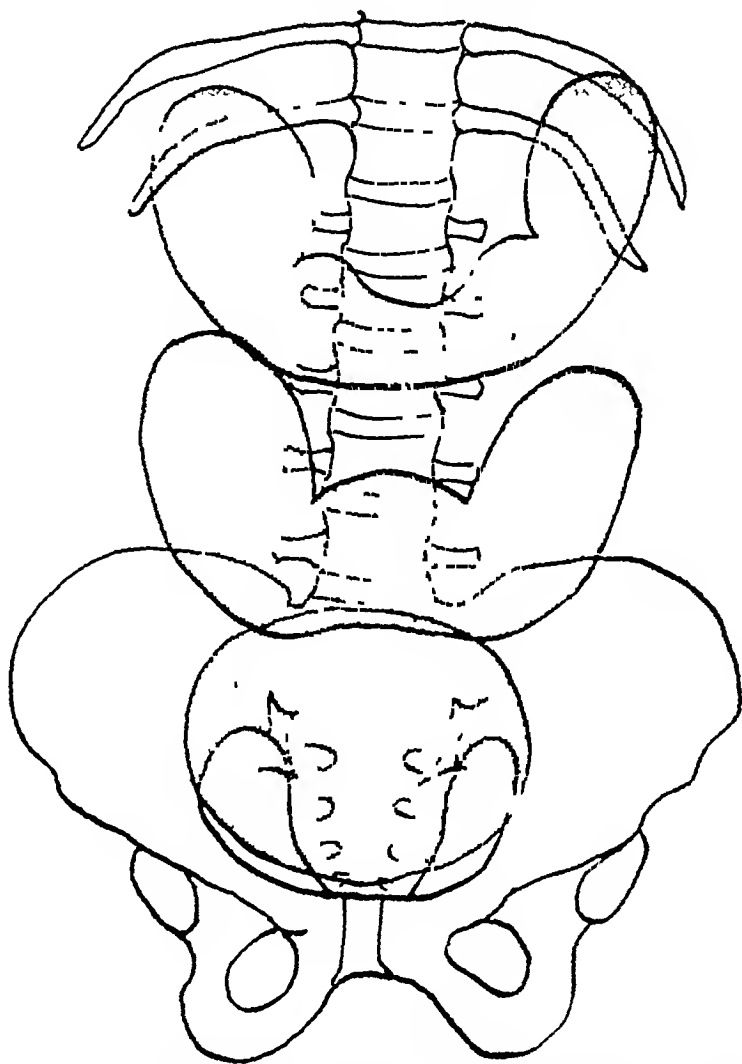


FIG 33 —Combination of horseshoe kidney and ectopia. Note from above downward low lumbar iliac and pelvic ectopia of the horseshoe kidney. The first two are the usual levels at which horseshoe kidneys are found. The pelvic type is always of the 'cake' variety.

C 5 Combination of ectopia (ordinary) and horseshoe kidney (Fig 33)

D CONCOMITANT ANOMALIES (FIG 34)

We will simply enumerate without taking up in detail the three principal groups of concomitant deformities, namely, (a) of the urinary tract in both sexes, (b) of the genital tract in the male, (c) of the genital tract in female

(a) Concomitant urinary defects

Exstrophy of the bladder

Congenital dilatation of the bladder

Diverticula of the bladder

Congenital strictures or valve formations of the posterior urethra

(b) Genital tract in the male (Fig 34, B) Phimosis Hypospadias
Non-descent of the testis
Agenesis or lack of formation of the testis, prostate or seminal vesicles

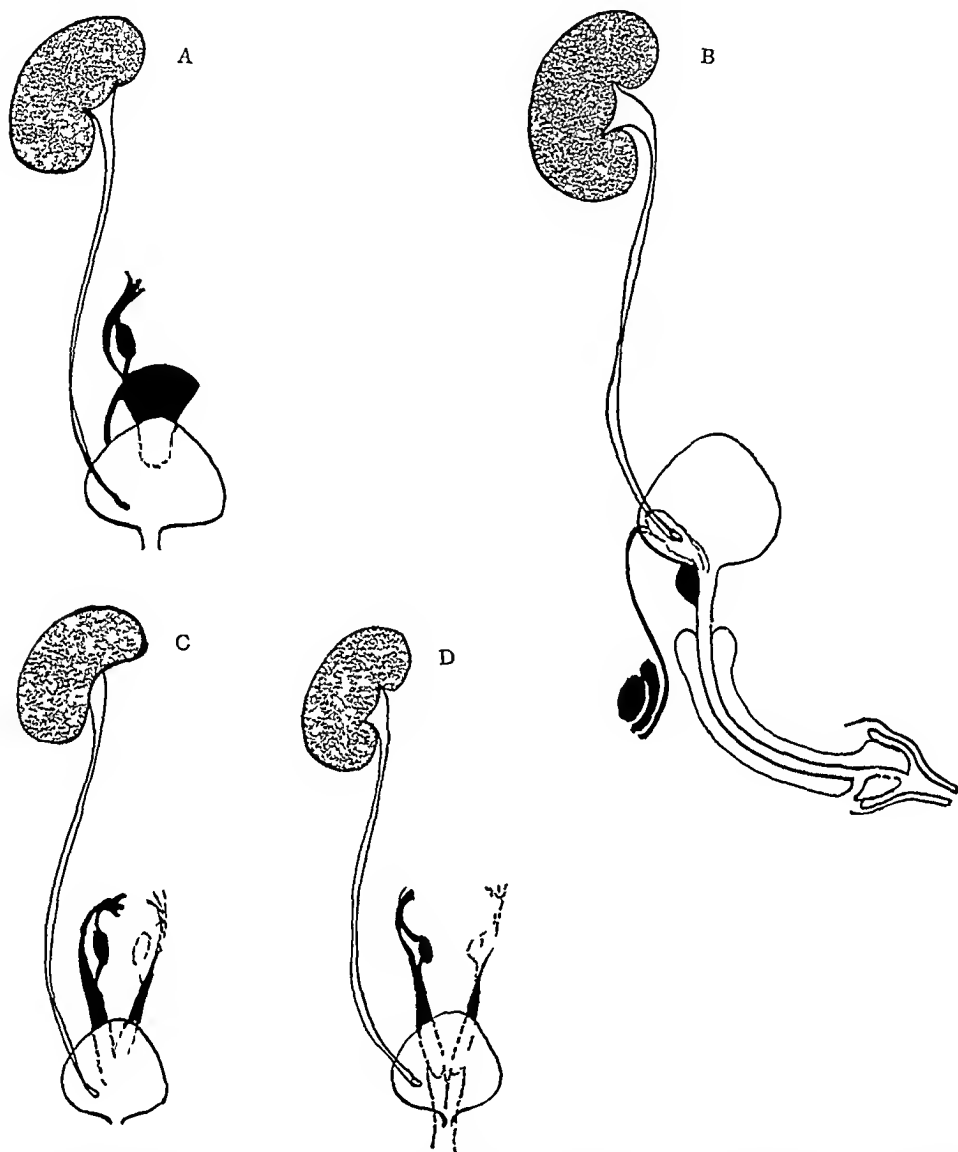


FIG 34 —Various concomitant genital anomalies In the female A Absence of ovary and tube on opposite side in congenital solitary kidney B Reduplication of uterus and vagina (with or without absence of a tube or of the ovary) C Uterus bicornis (with or without absence of a tube or of the ovary) In the male Most common anomalies are phimosis hypospadias absence of a seminal vesicle of lobe of prostate of a testis or of entire genital apparatus of one side

(c) In the female (Fig 34, A, C, D) Double vagina Double uterus
Bicornate uterus Absence of the ovary on one side Absence of the tube on one side Absence of uterine cornu on one side Infantile uterus

We have attempted to classify all of the anomalies of the kidney and ureter in as simple a manner as possible without omitting any essential points We offer it as a plan which will facilitate the writing of articles on this subject

SPINAL ANÆSTHESIA WITH ANHYDROUS COCAINE¹

OBSERVATIONS ON 557 ADDITIONAL CASES

By J RALSTON WELLS, M D

OF PHILADELPHIA, PA

My ORIGINAL report in ANNALS OF SURGERY, April, 1920, was based on observations of a series of twenty-six cases of spinal anæsthesia in which anhydrous cocaine only was used as the anæsthetic agent. In so small a number, conclusions, if drawn, were of little value and could only serve as a guide for further studies.

Laboratory experimentation and clinical experience in the past six years with five hundred and fifty-seven patients have resulted in refinements of technic and safeguards to the patients, as well as a feeling of security to the surgeon. All observations are from personal experience without conscious relation to findings or conclusions of other surgeons using spinal anæsthesia.

The technic used originally by Dr. Paul Delmas, University of Montpellier, France, has continued to form the basis of our procedure. The instrumentation is so simple that any surgeon can use this form of spinal anæsthesia without special apparatus. A Luer fitted spinal puncture needle of No. 17 gauge, three or three and one-half inches in length, a two-inch Luer needle No. 18 gauge, and a twenty-five c.c. all glass Luer syringe, constitute the entire equipment.

The posture of the patient for administration is of no moment. I prefer the sitting position when possible. Tincture of iodine, followed by alcohol or a 2 per cent. mercuriochrome solution, is painted over an area from the second lumbar vertebra to the sacrum and from crest to crest of the ilium. The skin at a point below the spine of the fourth lumbar vertebra, Tuffier's Point, is infiltrated with local anæsthesia. A tenotome puncture directly in the midline relieves the spinal needle of undue skin resistance. The needle is introduced directly in midline and at right angles to the skin surface. After the subarachnoid space is entered, the stilet is removed and the syringe is securely attached to the needle. The pressure of the spinal fluid often is enough to fill the syringe but if not, slow and gentle traction may be applied to the plunger. When twenty-five c.c. of the fluid is withdrawn the syringe is disconnected and the stilet reinserted, allowing the needle to remain *in situ*. The two-inch No. 18 gauge needle is attached to the filled syringe and a measured amount of the spinal fluid is injected into the amber glass ampule which contains the dry crystals of anhydrous cocaine. The amount of cocaine in the ampule has been accurately weighed and varies from gm. 0.45 to gm. 0.6. The quantity of spinal fluid put into the ampule is enough to make each c.c. equal to gm. 0.1 of the cocaine. The crystals dissolve instantly and the specific gravity of the spinal fluid is unaltered. The fluid remaining in the syringe is sent to the laboratory for routine examination, including a Wassermann and Colloidal Gold tests.

¹ Read before the Philadelphia Academy of Surgery, January 3, 1927.

The duration of the anæsthesia is determined by the amount of cocaine used, and will be found to vary but slightly from the accompanying table

Gm 01	20 minutes
Gm 015	45 minutes
Gm 02	1 hr 15 minutes
Gm 025	1 hr 50 minutes
Gm 03	2 hrs 30 minutes

The analgesia is of the same degree whether a small or large amount of cocaine is used, time only is altered by the amount

The determined amount of the cocaine solution is sucked into the syringe, the small needle is detached, the stilet removed from the spinal needle and the syringe *securely* reattached. From fifteen to twenty-five c c *more* of the spinal fluid is drawn from the spinal canal into the syringe, using gentle traction on the plunger. The amount withdrawn the second time is determined by the **patient's reaction**, which consists of a progressive headache generally occipital. In the early part of the series, we allowed the headache to increase until the patient uttered an involuntary high-pitched cry, but this has been found to be unnecessary. At present, we determine the point where the headache starts and continue to withdraw the fluid slowly, stopping when we judge the headache has almost reached the maximum. The reintroduction of the spinal fluid causes an immediate and complete cessation of the head pain. The entire procedure takes about three minutes. The entire contents of the syringe are now thrown back into the spinal canal with **force enough** to give the desired height level of analgesia. The height of analgesia is determined by the **force** exerted in reintroducing the spinal fluid-cocaine mixture. For personal convenience I recognize four pressures. Force I—Gentle and slow pressure giving analgesia to the level of the symphysis pubes. Force II—Slight pressure, giving analgesia to region of the umbilicus. Force III—Considerable pressure with consequent rapidity of reintroduction, which gives an area corresponding to the second rib anterior and including the arm. Force IV—All the pressure that can be obtained which gives analgesia of the whole body, including the head. The needle is removed and puncture sealed with collodion. The patient is placed in the position required for operation and given an intramuscular injection of c c 25 of adrenalin chloride solution (1-1000). This last procedure is the main modification of the original technic, and is very important. (See Chart 2.)

Blood-pressure, pulse, and respiratory observations are made every three to five minutes for the first fifteen to twenty minutes, and every ten minutes thereafter for the duration of the operation. Pulse and respiration are relatively unaltered.

The theory for withdrawal of spinal fluid and the constancy of obtaining various levels of analgesia in all individuals, large or small, is illustrated by this laboratory experiment. We are dealing with the spinal canal exclusive of the cisternum, and every spinal canal *varies* in its size and fluid content, but is *constant* in proportion to the size of each individual. We used a glass tube of a length and calibre proportionate

to the human spinal canal, and attached a half inch of rubber tubing to one end. The apparatus was held upright, rubber tube end down, filled with water and both ends sealed. A spinal puncture needle was introduced into the lumen through the rubber tubing, and a syringe filled with a methylene blue solution was attached to the needle. The blue, upon injection, was seen to permeate only the lower two inches. If half the water was removed from the glass tube before the blue was introduced, the blue permeated much higher, but if from this remaining half, two-thirds was removed into the syringe and re-injected, the entire fluid content became dyed. We used three sizes and lengths of tubes with approximately the same result, showing size or capacity is eliminated as a factor. By removing the spinal fluid in each patient to a common level or nearly so, as shown by the reaction of increasing headache we create two constant factors, a lack of "superimposed liquid," and a partial vacuum. The reintroduction of the liquid is propelled from behind, and is sucked in by a vacuum and, possibly due to normal irritability of living tissues, may be forced upward by ripples or successions of small contractions and expansions of the subarachnoid membrane itself. All three factors are augmented upon increase in force of the introduced liquid.

The cocaine that we are using at present has been prepared in the Laboratory of Pharmacodynamics of the University of Pennsylvania. The formula is that devised by Professor Gardin of the University of Montpellier, France. The finest cocaine obtainable is used. To one gramme of cocaine crystals in a glass flask, 25 c.c. of absolute alcohol is added, agitated, and allowed to stand three or four hours. Then while gently shaking the flask, 150 to 200 c.c. of dry ether is added. A crystalline deposit and precipitate are formed. This is allowed to stand from twenty to sixty minutes, the liquid is then syphoned off and the crystals dried in a sulphuric acid vacuum chamber. The crystals are removed in a sterile manner, weighed, and sealed in sterile amber glass ampules, care being taken not to allow the crystals to be long in contact with the air. A culture is taken from each ampule before sealing.

For experimental purposes, the syphoned liquid was evaporated and a substance obtained which resembled light brown sugar in color and texture. Several hundred ninety-gramme white rats were used and while the results were not conclusive, they were suggestive. I will not go into the minutiae of the experimentation but briefly state the gross results. We injected hypodermically Control rats, Group I, with the commercial cocaine in varying amounts, Group II, with anhydrous cocaine, and Group III, with the residue from the decanted liquid dissolved in normal saline solution. The rats in the second group were less affected than those in the first group for like amounts of cocaine, while those in the third group showed a marked susceptibility over either Groups I or II for like amounts by weight. The residue is apparently three or more times as toxic as the cocaine used in Group I. We have never been able to identify the residue from a chemical standpoint, which is unlike the original cocaine in color, crystalline formation and toxicity. We coined the term "Anhydrous Cocaine" to differentiate this product from all

others. It loses its cocaine crystalline formation and takes on the appearance of a flake, is hygroscopic and instantly soluble in water or spinal fluid. A new drug has not been created, but C P cocaine has been further purified, thus reducing its toxicity, making the cocaine thus obtained less toxic. The action of the cocaine is apparently unaltered in so far as analgesia is concerned. There is a large field of experimental work to be done before these facts can be established. Our work is to be taken as indicative only. I think with all fairness I may state that we have never had a death due to anhydrous cocaine spinal analgesia, *per se*. This in comparison with other reports, numerically equal on intraspinal cocaine use, shows a lessened toxicity. The future may reveal in the hands more able than ours, that this cocaine is less toxic for all general uses that cocaine may be put to. I would like to suggest that the term "Anhydrous Cocaine" be retained.

Several facts are peculiar to this anæsthetic. (1) The entire body, including the head, can be and has been safely rendered insensible to pain. (2) The height level of analgesia can be accurately determined within two inches. (3) The duration of the analgesia can be prognosticated within five to ten minutes. (4) The area of analgesia, once established, is unalterable, regardless of the position of the patient, whether prone, Fowler's, or Trendelenburg, and these positions may be changed during the operation without alteration of analgesic level. (5) Analgesia is immediate.

As cocaine in safe doses affects only sensory nerves, therefore, when introduced into the spinal canal shows a preference for the posterior roots, leaving the anterior roots unaffected. Anhydrous cocaine retains this quality, and permits analgesia of the entire body, yet leaves the motor and vital functions undisturbed. Herein it differs from all other local anæsthetics, stovaine, novocaine and apothesine included, in that each of them paralyzes both motor and sensory nerves.

The immediate analgesic action and its unvarying level once established, regardless of the patient's position, remain unexplained.

Cocaine deteriorates more or less rapidly in white or blue glass. The preparation we are using was made and sealed in amber glass ampules three years ago, and is as potent as when first prepared.

In addition to our five hundred and fifty-seven cases under anhydrous cocaine, we gave three novocaine, two stovaine-alcohol-acetic acid (Babcock), and one apothesine spinal anæsthesias. We have had one death under anhydrous cocaine in a very toxic patient with a severe myocarditis and almost moribund. Any operative procedure was of extreme danger regardless of anæsthetic used. There were nine failures of analgesia. Three of these were ascribed to inert cocaine due to the accidental heating of the ampules, and one, to failure to completely entering the spinal canal. In twenty-two cases, there was either poor analgesia or the effect wore off before the expected time, and in seven, a general anæsthetic was given on account of extreme nervousness of the patient. A failure of a little over $6\frac{1}{2}$ per cent.

By far the greatest proportion of operations were below the level of the umbilicus. There were seven gall-bladders, three rib resections, one major

thoracoplasty (removing a section of the second to ninth ribs inclusive), one compound fracture of the inferior maxilla, one lipoma of scalp, and two trephines

With the exception of thirty-two cases, all have been those that, in the opinion of the operating surgeon, were unfit for any other form of anæsthesia. They constitute the "last hopes" where surgical intervention is considered necessary to save life or to alleviate a lingering, painful existence. They include chronic alcoholics, drug addicts, all types of arteriosclerotics, the extremely obese, all grades of the intoxications including the diabetic, advanced cardiac and pulmonary conditions. Herein is a point of difference between this and most other spinal anæsthesia reports, and strengthens our opinion that we are using a less toxic drug than C P cocaine.

Two hundred and eighty-six cases (50 per cent) were nauseated or vomited within the first five minutes after spinal injection. Nausea terminated within eight minutes from time of onset in all but five cases, one of whom was nauseated for two days. The

nausea in these five may have been due to the anæsthetic or technic, but more likely to the pre-operative morphine. The inhalation of aromatic spirits of ammonia lessens the severity and length of the nausea and incidentally may raise the blood-pressure.

Blood-pressure has been our greatest problem. In common with all other

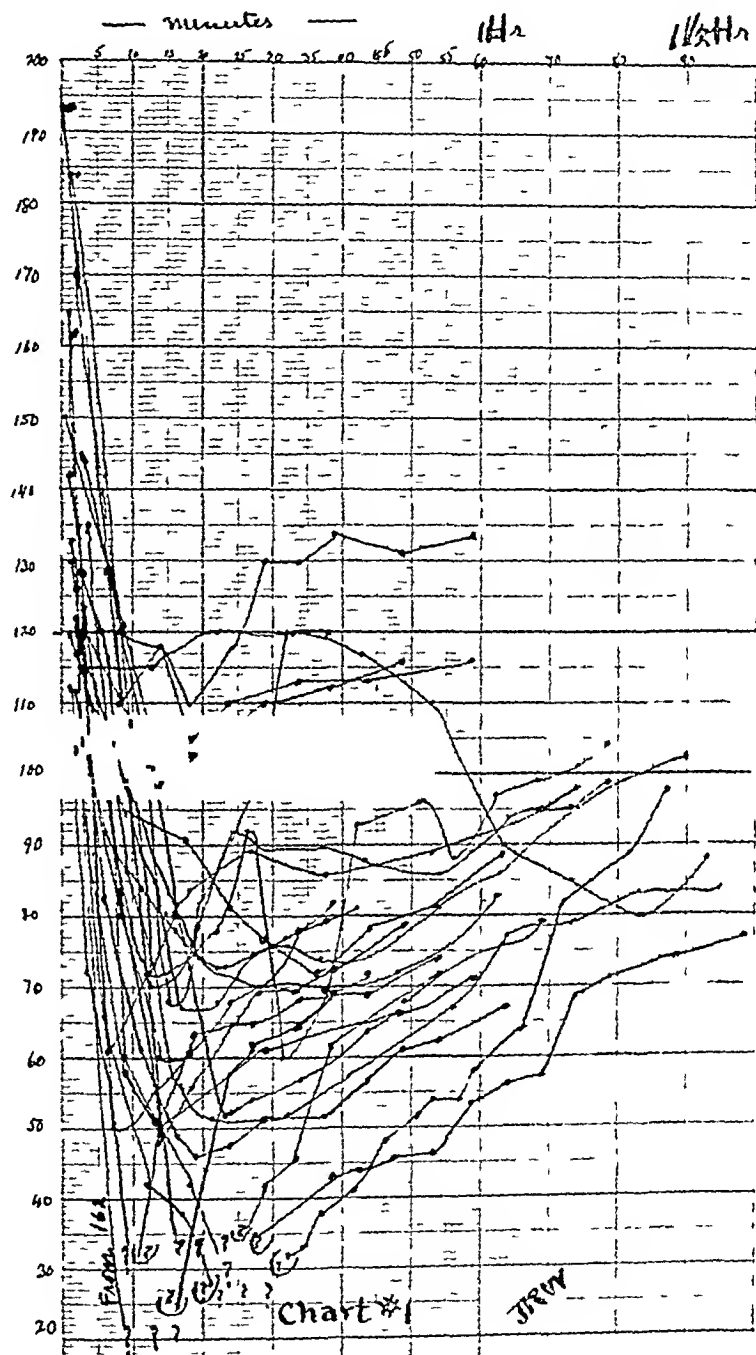


CHART I—Composite of twenty average curves taken from the first 150 cases. This gives the idea of the abrupt fall in systolic blood-pressure. Diastolic blood-pressure follows the systolic but not so marked the pulse pressure is therefore less. A larger number of cases are not charted on account of confusion of lines of curve. Diastolic pressures not charted for the same reason.

spinal anæsthetics of which I have any knowledge, anhydrous cocaine has a sudden, profound, depressing effect on the diastolic and especially the systolic pressure. A low blood-pressure constitutes the only other contra-indication to spinal anæsthesia, aside from spinal syphilis, tumors of the brain or cord, and

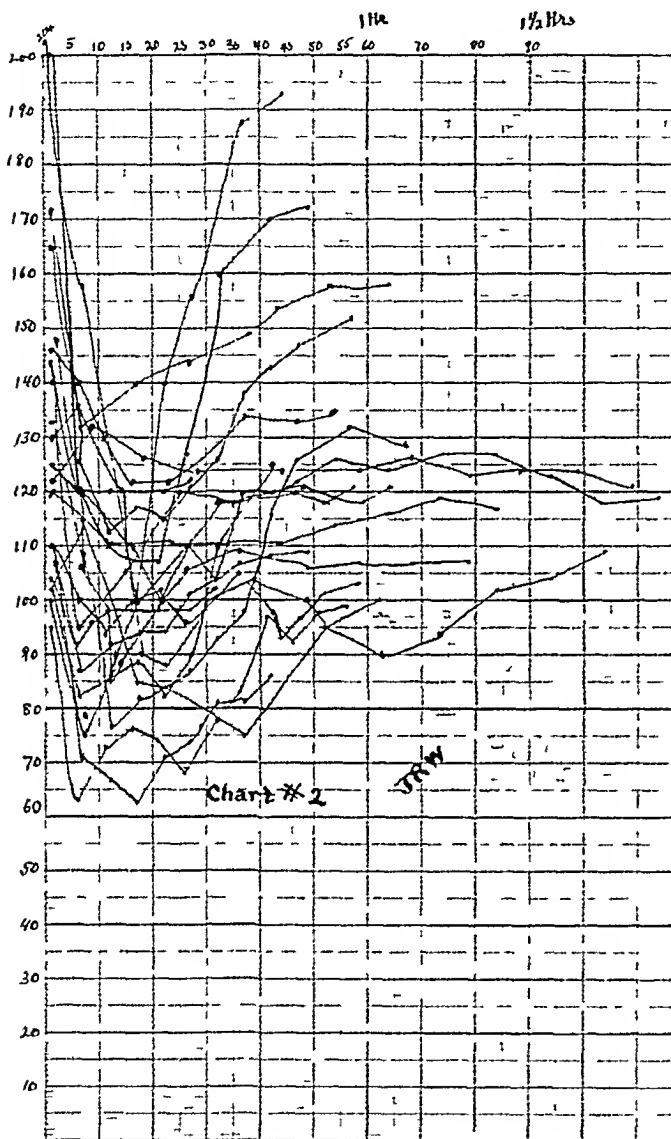
local suppurative processes in the immediate neighborhood of the spinal puncture. In the beginning of our series very little, if anything, was done to raise the blood-pressure when it became very low (Chart 1). Since then several drugs have been used alone and in combination, both before and after injection of the spinal canal. Doctor Delmas has suggested an elaborate mixture consisting of caffeine, spartein, sodium benzoate, and strychnine. We used this in sixteen cases. Pituitrin and ergot together were used in forty-four cases, ergot alone in twelve cases, and strychnine sulphate in six cases.

For the past two years adrenalin chloride 1-1000 solution has been used when a low blood-pressure was registered. Since lowered blood-pressure is an almost constant factor, it has become routine

CHART 2 —Composite of twenty average curves after the first 300 cases. Note the change in the general low limits due to the routine administration of adrenalin chloride solution 1-1000 intermuscular hypodermic. Several have had two injections of c c 0.25.

to give a moderate dose of adrenalin to every patient *immediately* following the spinal injection. If dose is administered deep in deltoid muscle, it will give positive results within sixty seconds. We have found a quarter of one c c to be sufficient in the majority of cases. Of two hundred and fifty-one thus routinely injected, sixty-four have needed one or two additional doses of same size. Ordinarily a patient should not be allowed a systolic pressure below seventy or diastolic below forty. Adrenalin chloride has not failed in emergency.

Two composite charts have been made (Chart 1 and Chart 2), one before



and one after the establishment of the routine administration of the adrenalin chloride. The first one shows pressures registered all the way down the scale, several falling below the audible stage. In one of these for seven minutes I could not feel a radial or carotid pulse, and could only hear a precordial beat. The first audible sound with a sphygmonometer was at 33. There was no differentiation between systolic or diastolic. The patient made an uneventful recovery. With the low pressures shown in the first chart consciousness very often lapsed for from one to fifteen minutes. With the second chart, we have *no* very low pressures and no lapses of consciousness. With too large a dose of adrenalin, however, we have had some dangerously *high* pressures. A quarter of a c.c. gives a decided reaction which lasts for fifteen to twenty minutes and if necessary, this dose may be repeated.

Normal pressures are reestablished in one to six hours, some requiring as long as eighteen hours. In one case a very toxic seventy-one year old man, with moist gangrene of a foot, having a pressure of 90 over 44, showed a rise of pressure to 120 over 70. We were not using routine adrenalin chloride at that time. He made a satisfactory recovery and left the hospital with the increased blood-pressure maintained. Two other cases have had rises of blood-pressure without adrenalin chloride, but neither one as well sustained.

The diastolic pressure is the most important, but owing to the systolic pressure being the most sensitive and the diastolic being usually in relative proportion, the systolic is here used to indicate recorded blood-pressure. By diastolic pressure is meant the absolute cessation of all sounds after the systolic high has been noted. In the occasional case the sounds continue to zero, but these are excepted. A patient with a systolic of 120 and a diastolic of 50 is a far greater risk than one of 100 over 60 or one of 160 over 110. One with a low diastolic shows a lack of resistance. A reasonable chart can be built on this theory of normal resistance with certain prognostic signs clearly indicated. With a pre-operative pressure of 140 over 90, a reasonable reading during the first five minutes would be 70 over 50, gradually rising to within ten points of normal in the next hour. If the curve is lower, for example, 55 over 30, and then the gradually rising pressure, we are uneasy until the rise is definite and our patient has been in danger of cerebral anæmia and the other results of acute hypotension. The administration of adrenalin chloride or any other drug will not alter the normal *resistance* curve as such (Chart 3), but will give a transient or false *pressure* rise and thus temporarily overcome the dangers of low blood-pressure. If the normal resistance has not recovered sufficiently when the adrenalin effect is spent a falling pressure recurs, and a second adrenalin dose is given. If the normal resistance has now recovered sufficiently to keep the pressure in safe levels, when the adrenalin effect is over, we do not need further drug action. The normal resistance is vital and should be given major attention in spinal anæsthesia. The low resistance curve can be prognosticated when the diastolic is abnormally lower than the systolic, or when the first several blood-pressure readings after the administration of spinal anæsthesia show a fall in diastolic as rapid or profound as in

the systolic Overstimulation with adrenalin chloride is a very real danger One case in this series rose from 63 to 180 systolic in ten minutes after the injection of one c c

The after effects of dizziness, headache, formication, "weak back," and many other recorded symptoms, are almost absent in this series We have had fourteen cases of headache, one lasting three days One case of unusual interest had a drooping of the left upper eyelid lasting for over two weeks and one case of blindness of the left eye for five days Neither was perma-

nent in the slightest degree Similar findings have been recorded following spinal puncture alone

Spinal pressure readings have not been made routinely, but if taken would undoubtedly be of interest when contrasted with the blood-pressure curve during the analgesic stage

Pre-operative preparation is of importance, as in any local anæsthesia At present we are using the three injections as advised by Gwathmey at

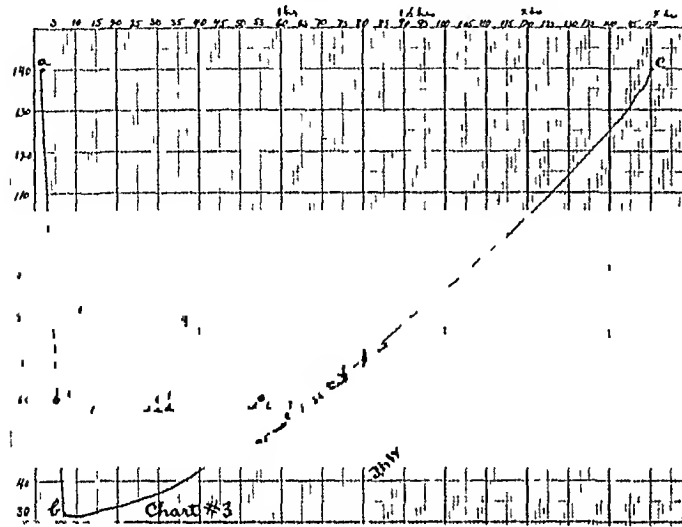


CHART 3 — This is at present theoretical We call the curve a-b-c the normal resistance line It represents the systolic pressure if left unaltered by drugs and therefore the reaction of the cardio vascular-motor system line d-e-f-g-h-i-j adrenalin chloride alters the pressure symptomatically and transiently but does not alter basic blood pressure At point j the adrenalin line crosses the normal resistance line and the necessity for further drug administration ceases

half-hour intervals, each consisting of morphine sulphate gr $\frac{1}{8}$, 2 c c of 50 per cent solution of magnesium sulphate This is injected intermuscularly For a 9 A M operation, give doses at 7 30, 8 and 8 30 A M We add atropine sulphate, gr $\frac{1}{100}$, to the second injection In the past both large and divided doses of morphine and atropine with and without scopolamin, were used, but the present technic has proved the most satisfactory

The rapid perfection and safety of other forms of local anæsthesia will cause them to supplant the spinal procedure in a large measure, but in certain cases, spinal anæsthesia will be the one of choice Whether anhydrous cocaine is less toxic than that obtained commercially, is yet to be adequately proven, but in our hands it has been safe, reliable, and easily controlled

I wish to express my appreciation for the facilities and aid, both material and advisory, extended by the Department of Pharmacodynamics of the University of Pennsylvania, the Department of Health of the City of Philadelphia, and by the Hospital and Laboratory of the Philadelphia General Hospital

back advocated the circular infiltration of novocaine proximal to the site of fracture causing a conductive anæsthesia, a procedure involving the same technical objections which pertain to the infiltration method. Except for Braun's report in 1913, of the successful reduction of twenty upper extremity fractures and dislocations, by the brachial plexus block in a general series of fifty cases reduced by "local methods," no mention was found in the literature of a series of cases treated by the method under consideration.

Our study was confined specifically to regional anæsthesia by nerve block, as this seemed to be the desirable and logical method to be used in the presence of the pathology associated with fractures and dislocations. The actual infiltration of an anæsthetic fluid into or about the traumatized tissues involved in any osseous or joint injury seems to us an unsurgical and objectionable procedure, as it means further traumatization to already injured tissues and adds potential factors to delay healing and increase the possibilities of infection. It is obviously contra-indicated in the case of the compound fracture, as well as the simple fracture with severe injury to the soft parts. In principle, the infiltration method is the conversion of the simple fracture into a compound fracture, and although some of the advocates of this method are willing to relegate these objections to a theoretical level, because of confidence in aseptic methods and failure of infection in a very limited series of cases, we feel the method is unsurgical, and should rarely be attempted.

Nerve block produces an anæsthesia of an involved area and avoids damage to the already injured tissues. In principle, its use depends upon the physiological section of a nerve at any level by depositing an anæsthetic fluid in or in close proximity to it with a resultant anæsthesia of the region it supplies. Anatomical levels favor us with sites of variable selectibility to block the nerves to anæsthetize any local area. The injection of a given solution close to the spine and at the emergence of the nerve trunks is called "paravertebral block." Injection through the posterior foramina of the sacrum to anæsthetize the sacral nerves is termed "transsacral block." The types of lesions, with which we are concerned, are essentially those of the upper and lower extremities. Thus a physiological section of the brachial plexus at the proper site with the proper technic will anæsthetize the whole upper extremity, similarly the block of the individual nerves—median-ulnar-radial—at the elbow will anæsthetize the forearm and hand, a block of the sciatic or the popliteal nerves in the popliteal space, the leg and foot, or in principle the deposition of the drug about any nerve will temporarily anæsthetize the area it controls.

To estimate the actual value of nerve block anæsthesia as a procedure for use in fracture work, an attempt was made to determine its efficiency in fulfilling the various requisites of a satisfactory anæsthetic. Any anæsthetic used in the reduction of fractures and dislocations may be said to have two prime requisites. The first, is to render the procedure painless, and the second is to establish adequate muscle relaxation to allow the restoration of fragments to desirable positions.

The choice of the type of case was governed by the therapeutic indications

REGIONAL ANÆSTHESIA IN FRACTURES

more or less standardized for this clinic. The main criterion was that the type of fracture or dislocation be one that should warrant an immediate manipulative reduction under an anæsthetic, in contra-distinction to the one indicating prolonged traction and suspension. The adaptable cases are essentially those of the extremities and our series includes one or more of each type (Table I). In the upper extremity, all fractures and dislocations are suitable, but in this clinic, those of the neck and shaft of the humerus are commonly treated by traction and suspension. In the lower extremity, the fractures of the femur are not available to nerve block because of anatomical inaccessibility, and moreover, because they are treated almost without exception, by traction and suspension. The lesions of the leg and foot are however, available to regional nerve block methods.

TABLE I
Types Treated

Upper extremity	Number of cases
Dislocation of shoulder	3
Dislocation of elbow	2
Fracture of humerus	2
Fracture of shaft of radius and ulnar	3
Fracture of shaft of radius	1
Fracture of lower extremity of radius (Colles)	12
Dislocation of first metacarpal	2
Fracture of metacarpal	3
Fracture of phalanges	5
Dislocation of phalanges	3
Fracture of shaft of tibia and fibula	1
Fractures of lower extremity of tibia or fibula (Potts)	5
Fracture of external malleoli	2
Fracture of os calcis	2
Fracture of metatarsal	2
Fracture of phalanges	2

As far as our first factor is concerned, the method has been almost uniformly satisfactory. (See Table II.) The state of analgesia if the technique has been properly carried out, is readily acquired and usually lasts one to two hours. At times, however, other afferent sensibilities, *e g*, pressure, position, and vibratory sensation, are apparently not obliterated, but greatly diminished so as to give the patient a conscious sensibility which may be slightly disagreeable, but not painful. Unless proper cooperation is obtained, these may be misinterpreted. During the actual manipulations, they naturally may become more pronounced, but at no time do they become of such moment as to be a potential source of shock. The patient may moan or complain, and then later admit he had no pain. These afferent sensibilities may be variable and most frequently are obliterated, but to guard against their presence being a factor for failure, it is necessary to allay mental apprehension and obtain the cooperation of the patient. These precautions are necessary to insure the success of any "local" operation, and the preliminary use of morphine when

SIGMUND MAGE

TABLE II

Number	Diagnosis	Procedure	Analgesia	Relaxation	Result
4275	Fracture of lower extremity radius—"Colles"	Elbow	Complete	Adequate and satisfactory	Successful
3148	Lower extremity of radius and ulnar—Styloid—Colles	Elbow	Complete	Adequate and satisfactory	Successful
11045	Lower extremity of radius—Colles	Bracheal	Complete	Adequate and satisfactory	Successful
8882	Lower extremity of radius—ulna—Styloid—Colles	Bracheal	Complete	Adequate and satisfactory	Successful
4546	Lower extremity of radius—ulna—Styloid—Colles	Bracheal	Complete	Adequate and satisfactory	Successful
4748	Lower extremity of radius and ulna—Styloid—Colles	Elbow	Conscious of pressure	Spasm and resistance of arm musculature	Successful
6041	Colles—Lower extremity of radius	Bracheal	Complete	Adequate and satisfactory	Successful
11275	Lower extremity of radius—Colles	Bracheal	Complete	Adequate and satisfactory	Successful
11270	Colles—Lower extremity of radius	Elbow	Complete	Spasm and resistance of arm musculature	Successful
6534	Colles—Lower extremity of radius	Elbow	Conscious of pressure	Spasm and resistance of arm musculature	
7293	Colles—Lower extremity of radius	Bracheal	Complete	Adequate and satisfactory	Successful
6888	Colles—Lower extremity of radius	Bracheal	Complete	Adequate and satisfactory	Successful
4349	Dislocation of shoulder—Subcoracoid	Bracheal	Complete	Adequate and satisfactory	Successful
11976	Dislocation of shoulder—Subcoracoid	Bracheal	Complete	Adequate and satisfactory	Successful
11552	Dislocation of shoulder—Subcoracoid	Bracheal	Complete	Adequate and satisfactory	Successful
7236	Dislocation of elbow—Backward	Bracheal	Conscious of pressure	Adequate and satisfactory	Successful
F K—Private	Dislocation of elbow—Backward	Bracheal	Complete	Adequate and satisfactory	Successful

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TABLE II—Continued

Number	Diagnosis	Procedure	Analgesia	Relaxation	Result
4756	Fracture of shaft of humerus—Middle $\frac{1}{3}$ —Open operation	Brachial	Conscious of pressure	Adequate and satisfactory	Successful
13855	Fracture of lower extremity of humerus—External condyle	Brachial	Complete	Adequate and satisfactory	Successful
3381	Fracture of shaft of radius and ulna—Middle $\frac{1}{4}$	Elbow	Conscious of pressure	Spasm of arm muscle	Successful
6757	Fracture of shaft of radius and ulna—Middle $\frac{1}{4}$	Brachial	Complete	Adequate and satisfactory	Successful
1791	Shaft of radius and ulna—Middle $\frac{1}{4}$	Elbow	Complete	Spasm of arm muscle	Successful
6534	Dislocation of first metacarpal	Median and radial	Complete	Adequate and satisfactory	Successful
3952	Dislocation of first metacarpal	Elbow	Complete	Adequate and satisfactory	Successful
1817	Fracture of first metacarpal—Compound	Elbow—Radial and median	Complete	Adequate and satisfactory	Successful
7371	Fracture of shaft—First metacarpal	Radial and median	Complete	Adequate and satisfactory	Successful
8162	Fracture of shaft—Fifth metacarpal	Ulna	Complete	Adequate and satisfactory	Successful
3651	Compound fracture of proximal phalanges—3, 4, 5 fingers	Elbow	Complete	Adequate and satisfactory	Successful
5220	Compound fracture of phalanges—1, 2, 3, 4	Elbow	Complete	Adequate and satisfactory	Successful
11314	Fracture of proximal phalanx—Index	Lateral nerves	Complete	Adequate and satisfactory	Successful
11520	Fracture of proximal phalanx—Index	Lateral nerves	Complete	Adequate and satisfactory	Successful
8176	Dislocation of proximal phalanx ring finger	Lateral nerve	Complete	Adequate and satisfactory	Successful
6071	Dislocation of proximal phalanx 5th finger	Ulna	Complete	Adequate and satisfactory	Successful
6074	Dislocation of second phalanx—Index finger	Lateral nerve	Complete	Adequate and satisfactory	Successful

TABLE II—*Continued*

Number	Diagnosis	Procedure	Analgesia	Relaxation	Result
5395	Compound fracture of phalanges—1, 2, 3, toes	Ankle	Complete	Adequate and satisfactory	Successful
3950	Dislocation of proximal phalanx—Index	Median	Complete	Adequate and satisfactory	Successful
7371	Fracture of lower extremity of tibia and fibula	Popliteal	Complete	Adequate and satisfactory	Successful
4420	Fracture of shaft of fibula lower $\frac{1}{3}$ —Lower extremity of tibia	Popliteal	Complete	Adequate and satisfactory	Successful
4412	Fracture of shaft of fibula—Lower $\frac{1}{3}$ and lower extremity of tibia	Popliteal	Complete	Adequate and satisfactory	Successful
4956	Fracture of shaft of fibula—Lower $\frac{1}{2}$ and lower extremity of tibia	Popliteal	Complete	Adequate and satisfactory	Successful
5522	Fracture of lower extremity of fibula—Lateral malleolus	Popliteal	Complete	Adequate and satisfactory	Successful
1355	Fracture of lower extremity of fibula—External malleolus	Popliteal	Complete	Adequate and satisfactory	Successful
6897	Fracture of shaft of fibula—Lower $\frac{1}{3}$	Popliteal	Complete	Adequate and satisfactory	Successful
4931	Fracture of os calcis	Ankle block, Anterior and posterior nerves	Complete	Spasm and resistance of Tendo-Achillis	Unsuccessful
5634	Os calcis	Popliteal	Complete	Adequate and satisfactory	Successful
6030	Fracture of first metatarsal	Ankle block	Complete	Adequate and satisfactory	Successful
4640	Fracture of first metatarsal	Ankle block	Complete	Adequate and satisfactory	Successful
4540	Compound fracture and dislocation of first phalanx—Large toe	Ankle	Complete	Adequate and satisfactory	Successful
2183	Fracture of proximal phalanx—Middle	Median and ulna	Complete	Adequate and satisfactory	Successful
6576	Compound fracture of shaft of tibia and fibula—Middle $\frac{1}{3}$	Popliteal	Conscious of pressure	Spasm and resistance of thigh muscles	Successful

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not contra-indicated, dulls sensibility sufficiently to acquire this end. As a routine part of every procedure, the patient is given $\frac{1}{4}$ gram of morphine. This has been apparently sufficient to remove these features.

The second requirement of any satisfactory anæsthetic in fracture work is the capacity to supply adequate muscle relaxation. Malposition of fragments are most often dependent on the resultant of muscle forces, and muscle spasm is frequently the chief factor in preventing ready reductions. Judging from our experience with general narcosis, it would seem that complete muscle relaxation is essential, before manipulations can be attempted, as the lighter stages of anæsthesia tend to increase muscle spasm and render procedures more difficult. Experience with complete regional blocks for other surgical conditions revealed that chiefly the sensory elements are modified and the motor elements less so. As a rule, when the brachial plexus is blocked, there is the complete loss of pain sensibility, and usually a loss, or a diminution of pressure, position, and vibratory senses. Motor function is considerably modified but not obliterated. The patient can move his fingers, wrist, and forearm, but rarely can he lift his arm from a dependent position or offer any synergic resistance to opposing effort. The tonicity of the musculature is altered to a striking degree and a muscle paresis, but not a paralysis, prevails. The same general conditions are found with other regional blocks. The degree of this residual tonicity to all intent and purpose, seemed apparently negligible, but because of its practical importance in this particular problem, it was felt necessary to evaluate its actual and its potential limitations.

The most practical way to determine the adequacy of muscle relaxation after nerve block, seemed to be to try the method on cases presenting the most unfavorable mechanical factors without considering the question of specific anæsthetic indications. Although an attempt was made to select the cases with this point in mind, the criterion for the type of fracture or dislocation to be tried was, as previously mentioned, the one established at this clinic for immediate manipulative reduction under an anæsthetic. Well-developed musculature, delayed reductions and malpositions are perhaps the chief factors which prevent ready reduction and demand the greatest degree of muscle relaxation. If nerve block anæsthesia should prove adequate under these conditions, its efficiency would be well established, especially in its indicated sphere where usually more favorable mechanical conditions exist.

The following are examples of the type of cases chosen to test the capability of the method for supplying adequate muscle relaxation.

CASE No. 4349—Patient, chauffeur, thirty-five years of age, weight 210 pounds. Unusually well-developed musculature. Diagnosis—anterior dislocation of right shoulder and fracture of the greater tuberosity with marked separation. The injury was forty-eight hours old and two attempts at reduction elsewhere, had been unsuccessful. This case, presenting a patient with powerful musculature, an extreme degree of dislocation and delayed reduction of forty-eight hours would seem to present all the factors requiring a greater degree of muscle relaxation for successful reduction. A preliminary hypodermic injection of morphine sulphate gram $\frac{1}{4}$, was given and a brachial plexus block was done with 2 per cent neocaine. The procedure was carried out under the fluoroscope, and the

dislocation and fracture were readily reduced by a Kocher method without any discomfort to the patient. The degree of muscle relaxation seemed to be quite as complete as one obtains with general narcosis.

CASE No 4540—Longshoreman, age thirty-four, diagnosis—muscular type, alcoholism, laceration of scalp and nose, fracture of nasal bones, Colles' fracture with marked dorsal displacement and impaction. Duration—twelve hours. The patient was uncooperative, of a muscular type, a chronic alcoholic, had multiple injuries as well as a respiratory infection, and presented a combination of unfavorable mechanical factors for reduction, as well as factors contra-indicating general narcosis. A brachial plexus block was done by the supra-clavicular method with 2 per cent neocaine. Relaxation was quite complete and the patient who, at the outset was uncooperative, offered no difficulty or resistance to the procedure, and a successful reduction was accomplished.

CASE No 7371—Longshoreman, age forty-two. Diagnosis—Potts' fracture. Duration—forty-eight hours. Reduction was attempted under general anesthesia forty-eight hours before, but was unsatisfactory because of a persistent widening of the mortise of tibio-fibular articulation and malposition of astragalus. This case presented the factor of delayed reduction in a difficult fracture. Popliteal space block was done with 2 per cent neocaine, and fracture was easily corrected under direct vision by aid of the fluoroscope.

CASE No 4420—Longshoreman, muscular type, age forty. Diagnosis—Potts' fracture. Duration—three hours. This patient presented a combination of a powerful musculature with a moderately severe fracture. The popliteal space block was adequate for reduction and offered satisfactory relaxation.

CASE No 8882—Seaman, powerful muscular type, age sixty-five. Diagnosis—Colles' fracture with marked displacement and impaction. Duration—twenty-four hours. This patient presented the combination of a well-developed musculature and advanced age, although general excellent condition of patient would have tolerated a general anæsthetic. Fracture was readily reduced by brachial plexus block with satisfactory muscle relaxation.

CASE No 11314—Printer, age sixty. Diagnosis—fracture of proximal phalanx of left index finger. Duration—one week. Arteriosclerosis and chronic bronchitis. The over-riding and malposition of the fragments were such that if the position were not corrected, a disabled finger would have resulted. This patient presented the factor of delayed reduction as well as unsuitability for general narcosis. An attempt made to correct this deformity, without anesthesia was unsuccessful. Although the fracture was a week old, a lateral nerve finger block allowed for relaxation and painless manipulations to correct the position and maintain retention of the fragments without the need of traction.

The examples cited, seemed to present those factors which would necessitate the obtaining of that certain degree of relaxation necessary before reductions could be accomplished. In these instances, the indicated nerve block procedures, as explained later, had been instituted, and the resulting muscle relaxation was, at all times so satisfactory, that any residual tonicity persisting was practically negligible. In our whole series of fifty fractures, various available procedures were tried with the idea of evaluating their merit and indications, and in some instances the resultant muscle relaxation was not as complete and satisfactory as could be desired. The related factors, some of them avoidable and others unavoidable, were recognized and will be discussed later. However, with the method not always used in the ideal manner, we were able to reduce successfully forty-nine of the fifty fractures attempted (Table II). The only unsuccessful case was a fracture of the os calcis, which could not be reduced under general narcosis and necessitated an open operation. The failure was obviously not due to anesthesia. These uniformly successful results established to our satisfaction that nerve block

fulfils the second requisite of a satisfactory anæsthetic, namely, to supply adequate and sufficient muscle relaxation to cope with the mechanical factors of adaptable fractures and dislocations

In any fracture, the obvious plan is to block the nerves proximal to the site of fracture, and, depending on that site, various levels may be available. Thus the reduction of a dislocated wrist-joint may be attempted with either a block of the median and ulnar nerves at the wrist, a block of the median, ulnar, and radial at the elbow, or a brachial plexus block. In our series, we tried these various procedures with the purpose of establishing their comparative value and this fact in part explains some of the instances where muscle relaxation was not entirely satisfactory, although in all instances it was adequate for successful reduction. Similar types of lesions were reduced with blocks at various levels to determine the possible advantages of one procedure over another, and the following examples illustrate the factors involved.

CASE No 3381—Fracture of radius and ulna—middle third. This fracture was anesthetized by an elbow block and successfully reduced but the arm musculature seemed to retain its tonicity and add sufficient muscle spasm to make the reduction more difficult and not as satisfactory as one would ordinarily have expected with a general anæsthetic.

CASE No 6757—Fracture of shafts of radius and ulna junction—middle third and lower third was, in a sense similar in its mechanical problems to Case No 3381. It was anesthetized by a brachial plexus block, which eliminated the resistance of upper musculature, and the reduction was accomplished as readily and satisfactorily as could be expected.

These examples emphasize the distinct regional character of the nerve block method, and the necessity of appreciating the related factors involved in obtaining maximum results. In the elbow block, the whole musculature distal to the level is affected, while the tonicity of the arm musculature, which is not anesthetized remains practically unaltered. In the brachial plexus block, anesthetization involves the whole upper extremity, and degree of relaxation resulting therefrom, has proved sufficiently complete to reduce fractures and dislocations attempted without feeling the need for more relaxation.

The factor of regional anesthetization of muscle groups and its related importance to the circumstances of the fracture, was further emphasized in a series of Colles' fractures, where the tonicity of the arm musculature would seem to be a less important source of resistance.

In Cases Nos 3148, 4275 Colles' fracture of simple dorsal displacement and slight impaction, reductions satisfactorily accomplished with elbow block.

Cases Nos 11270, 7418 Colles' fractures where displacement and impaction were marked, reductions were accomplished by elbow block, but tonicity of arm musculature seemed to offer sufficient generalized resistance to make procedure more difficult than would be expected with general anæsthesia.

Cases Nos 8882, 11045 Colles' fractures comparable to Cases Nos 11270, 7418, reductions were accomplished with brachial plexus blocks. The absence of the arm muscle tonicity, allowed for a greater generalized relaxation and more ready and satisfactory reductions resulted.

These experiences show that the maximum efficiency of the method is dependent upon the procedure instituted, which is further governed by site

and the type of fracture and general musculature of the patient. These factors must be kept in mind, not only in selecting the procedure to be employed, but also in determining the method's value and indications. In elbow fractures or dislocations, or fractures of both bones of the forearm, the arm musculature is a definite factor in resistance, and the upper level of the brachial plexus adequately eliminates that undesirable factor. In Colles' fracture or fractures at a lower level, the nature and type of fracture and general musculature become the factors in determining the type of procedure. Obviously, fractures above the elbow level must be reduced under the brachial plexus block.

The same general principles pertain in the fractures of the lower extremity, but perhaps to a greater degree, because the interrelationship of muscle groups is more pronounced, the musculature more powerful, and the reductions usually more difficult. Seldom, at this clinic, are fractures of both bones of the leg with malposition, treated by immediate manipulative reduction and plaster retention. Badly over-riding fractures of the tibia and fibula, as well as spiral fractures with potential slipping are treated by traction and suspension, *e.g.*, Steinman pin through the os calcis or calipers in the malleoli. The compound fractures necessitating debridement, and those with slight malposition may be subjected to immediate reduction under regional anæsthesia. Unless there is some definite contra-indication to general anæsthesia, nerve block is not advocated, although the adequacy of the method for these lesions was definitely established. As the procedure must be done either at the popliteal space, or by a sciatic nerve block, the tonicity of the thigh muscles is usually great enough to add to the difficulty of the reduction.

Fractures about ankle satisfactorily treated by popliteal space block, without any unfavorable, resisting muscle spasm by the tonic thigh muscles.

Case No. 7371 cited as an example of the type mechanically unfavorable to the method, a secondary reduction of a Potts' fracture forty-eight hours after an unsatisfactory reduction under general anæsthesia was readily reduced by a popliteal space block with adequate relaxation. Three other Potts' fractures were successfully reduced with adequate relaxation. Fractures of the malleoli which require only protective splinting may be painlessly handled by the popliteal space block, and thereby avoiding discomfort in the application of splints in the effort to obtain any desired positions.

Fractures and dislocations of the bones of the foot are most satisfactorily taken care of by popliteal space blocks, although metatarsal and phalangeal injuries may be handled by ankle blocks. Fractures of the os calcis which are amenable to correction or reduction should be blocked at the popliteal space to obtain relaxation of the Tendo-Achillis.

Fractures and dislocations of the phalanges, which require anæsthetics for correction have been treated very advantageously by block of the lateral nerves about the base of the finger or toe. The malposition of these lesions is not dependent upon interrelated muscle groups but mainly upon related tendons which may be sufficiently relaxed to offer no serious difficulty to the

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reduction. The advantages of carrying out these particular smaller but important procedures without the inconvenience of general anæsthesia are obvious.

With the efficiency of the nerve block method established, its definite indications become apparent. It is obviously indicated where any of the well-known objections to the use of general narcosis exist, and perhaps the greatest field for its use obtains, where the factors demanding the maximum degree of muscle relaxation are not so formidable. The fractures of the aged, as well as those unsuited for general narcosis because of some chronic systemic condition, usually do not present a well-developed musculature, and frequently a less perfect anatomical result may be tolerated. In this class, nerve block is ideal and is the procedure of choice. In the fractures of the vigorous where any special contra-indications to anæsthesia may arise, the method may be expected to be adequate and it then becomes the procedure of choice. Furthermore, under relatively normal conditions, it may, by a discretionary choice of case, become the procedure of preference. It spares the patient a general anæsthetic with its attendant disagreeable features and, because of the duration of the anæsthesia, the manipulations may be carried out freely and carefully under the fluoroscope without haste. It eliminates the excited recovery of general narcosis with its potential harm to a satisfactory reduction, and it avoids the frequent necessary hospitalization of a patient following that type of anæsthesia. We are not prepared to contend that these advantages overbalance the general usefulness of general anæsthesia in fracture work, and we grant their comparative value must be a matter of individual discretion. However, as nerve block proved efficient anæsthetic for fractures and dislocations with undoubted indications for its use, we feel justified in claiming that in these instances it becomes an excellent adjuvant in that type of work.

In our series, which, from the view of specific anæsthetic indication, was relatively unselective, cases were encountered which more or less illustrate the indications which we think pertain to the nerve block method. The following are examples.

CASE No. F. K.—(Private) Housewife, age thirty-four, four months pregnancy. Posterior dislocation of left elbow, duration—one hour. Because of the associated pregnancy and a fair degree of general reaction caused by the injury, it was thought preferable if possible to avoid a general anæsthetic. A brachial plexus block was done with 2 per cent. neocaine and a ready reduction was accomplished with adequate relaxation and no discomfort to the patient.

CASE No. 3148—Printer, age fifty-six. Diagnosis—Colles' fracture (left) with impaction and displacement, duration—one hour. Arteriosclerosis, emphysema and chronic bronchitis. This patient presented the factors of age, chronic respiratory condition, and the local fracture, where a satisfactory result was necessary for the successful continuation of his trade. Under ordinary conditions, as a fair functional result was conceivable, perhaps no attempt would have been made to correct this fracture, because of the necessity of subjecting the patient to a general anæsthetic. Under an elbow block, the fracture was satisfactorily reduced.

CASE No. 4412—Age sixty-three, Potts' fracture, duration—one hour, general arteriosclerosis. This patient was senile, and it was desirable to avoid general narcosis. A popliteal space block was adequate for reduction.

CASE No. 4540—Colles' fracture with impaction and poor position cited previously.

for factors preventing ready reduction definitely indicated a "nerve block procedure," because of the acute respiratory infection, alcoholism and multiple injuries. The fracture was satisfactorily reduced with a brachial plexus block.

CASE No. 11314—Fracture of proximal phalanx (cited previously) presented a chronic respiratory condition, arteriosclerosis and advanced age, and was reduced under lateral nerve block.

The above examples are but a few examples of the field of applicability of this method of anaesthesia.

Some consideration may be given at this time to the technical factors of the question, as the efficiency of the method is at times directly dependent on the choice of technical procedure. Our theme deals directly with the problem of a more or less well-defined clinical entity in relation to this form of regional anaesthesia, and not actually with the methods of producing any regional block. Naturally, as diversified as the lesions may be, so will the necessary technical procedures be. The discussion of the technical aspects of any of these, would require a detailed account of the local anatomy and special procedures as long as this theme itself, and is not within the province of this paper. In general, we have found no specific differences in the technical features to feel that any one procedure merited preference over another. Perhaps more concern is manifested over the brachial plexus block, because of conceivable complications attributed to it, *e.g.*, neuritis and paralysis. Thus far, in our experience, which is relatively limited, we have found the procedure comparatively simple and 100 per cent successful, and, in our whole series, have had no infections at the site of injection or evidence of any residual symptoms suggesting nerve trauma. No authentic reported series of regional blocks have been found to estimate a percentage incidence of possible complications. We feel that these are as few, and, perhaps fewer than the more serious complications of general anaesthesia, or the untoward accidents of a lumbar puncture, paracentesis, or thoracentesis. The sum and substance of the problem resolves itself into an appreciation of the several factors involved in any particular fracture or dislocation, and the criterion for the site of any injection is not one of technical difficulties, but the obtaining of the most adequate degree of muscle relaxation.

Some routine is advisable and we have been accustomed to manage our cases in the following manner. After the usual clinical examination, the patient is X-rayed and the diagnosis established. This is usually carried out without excessive discomfort. The actual character of the fracture as determined by the X-ray finding, should be one of the factors to determine the procedure. If a block is decided upon, it is important to get the patient's confidence and cooperation by explaining the nature and advantages of the forthcoming steps. It is essential to give a preliminary sedative which dulls sensibility and apprehension. Morphine, grains $\frac{1}{4}$, is given immediately before injecting, and it usually has its full effect by the time the patient reaches the fluoroscopic room. It is essential to have needles that are thin, sharp, and smooth, and a syringe which is serviceable. We feel the anaesthetic agent is important, and we have preferred "neocaine," because of an apparent

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superior action evidenced by a quicker analgesic onset and a longer duration of anesthesia. As soon as full anesthetization is obtained, which usually occurs in 15 to 20 minutes, the patient is taken to the fluoroscopic room. We frequently allow the patients to initiate the effort of getting on the table themselves and thus far, practically without exception, they have unconsciously attempted to use the injured member in doing so. Apparently a complete anesthesia allows for a dissociation of their injury by some new conscious impression, and we have used this reaction as one of the signs of thorough anesthetization especially in the nervous and apprehensive patient who is slow in admitting the lack of discomfort. By previously manipulating the local area for the patient's attention and benefit he is usually surprised by the lack of discomfort, and becomes more mentally assured. As the anesthesia usually lasts one to two hours, the necessary manipulations may be carried out with ease. Positions may be examined, checked and rechecked, retention apparatus applied and adapted by the time muscle tonicity begins to return. The procedures are devoid of the shock, unpleasantness and hazards of general narcosis, need not hospitalize the ambulatory patient and may be readily carried out wherever the proper aseptic precautions may be obtained, operating room, dispensary or private office.

SUMMARY AND CONCLUSIONS

1 In the reduction of fractures and dislocations, instances occur where general narcosis is contra-indicated and indicated therapy is thereby frequently disadvantageously modified.

2 Nerve block produces a regional anesthesia without compromise to the site of fracture or dislocation and obviates that potential damage which exists with the ordinary infiltration method of local anesthesia. Nerve block is thus surgically rational in presence of pathology associated with these lesions.

3 In series of adaptable fractures and dislocations indicating immediate manipulative reduction nerve block was found to be satisfactory anesthetic, by allowing painless reduction and by supplying adequate muscle relaxation.

4 Nerve block is an excellent adjuvant for use in fracture work, and is the indicated anesthetic where any contra-indication to general narcosis exists. Because of the many decided advantages pertaining with its use under ordinary circumstances, it may readily become the procedure of preference for the reduction of fractures and dislocations.

BIBLIOGRAPHY

- ¹ Conway, J. R. New York M. J., 1885, vol. XLII, p. 632.
- ² Reclus. L'anesthésie localisée par la cocaïne, Paris, 1903, p. 266.
- ³ Lerda, G. Ztschr. f. Chir., 1907, vol. XXXIV, p. 1417.
- ⁴ Quenu, E. Bull. et mem. Soc. de chir., 1908, vol. XXXIV, p. 976.
- ⁵ Braun, H. Deutsche med. Wchnschr., 1913, vol. XXXIX, p. 17.
- ⁶ Dollinger, B. Ztschr. f. Chir., 1913, vol. LI, p. 763.
- ⁷ Hagenbach, E. Schweiz. med. Wchnschr., May 26, 1921, vol. LI, p. 488.
- ⁸ Cohen, I. J. A. M. A., 1926, vol. LXXVI, p. 1896.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held January 3, 1927

The President, DR CHARLES F MITCHELL, in the Chair

BILATERAL CONGENITAL DISLOCATION OF HIPS

DR J W BRANSFIELD reported the case of Mary B, age two years, who was admitted to the St Agnes Hospital, November 1, 1926 Under



FIG 1 —Bilateral congenital dislocation of the hips

ether anaesthesia both hips were reduced by the closed method following the method advocated by the late G G Davis The reduction was done under the fluoroscope and it was interesting to note that if the muscles are stretched sufficiently the reduction can be accomplished by any method used in an acquired dislocation If the muscles are not properly stretched none of the fanciful movements advocated will influence the reduction The patient was dressed in plaster and the legs were placed in the "frog" position The case was removed in seven weeks Fig 1 shows the dislocation Fig 2 shows the dislocation reduced after the case was removed

DR FORREST WILLARD pointed out that the length of post-operative treatment was unusually short In all cases which have come to his orthopaedic service, it has been found that two months' fixation does not hold it in place, and it is an unique case which will not redislocate, after reduction, with only two months' fixation The general time of fixation for bilateral congenital dislocation of the hip is at least eight to twelve months Some surgeons advocate fifteen months Doctor Willard thinks that this is too long, but that short fixation of two, three or four



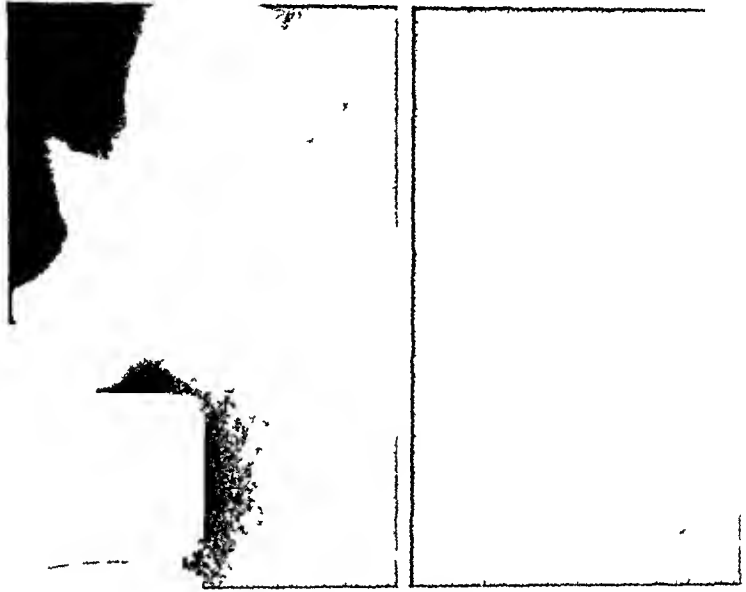
FIG 2 —The dislocation reduced

FRACTURE OF OS CALCIS

months is liable to later allow the hip to slip out of the socket, unless one finds a rare case in which the socket is of normal depth

CONGENITAL ABSENCE OF BODY OF THORACIC VERTEBRA

DR J W BRANSFIELD reported the case of John A., who was admitted to the St Agnes Hospital, October 26, 1926. The X-ray showed absence of the body of the seventh thoracic vertebra with a tilting of the spinous process of the eighth. From the history and X-ray study it was decided that this case was of the congenital variety. Under ether anaesthesia the vertebrae were exposed and the eighth thoracic was found to be easily moved and was restored to normal position. The spinous processes of IV, V, VI, VIII and IX were split after the method of Albee and a graft obtained from the tibia was placed in the groove. The graft was held with kangaroo tendon, the wound closed and a figure-of-eight dressing applied over back and shoulders. On removing the skin clips on the eighth day, a small blood clot was found but no infection occurred. Patient is in hospital at the present time. X-ray shows the graft to be in good position.



FRACIURE OF OS CALCIS

DOCTOR BRANSFIELD reported the case of James W., who was admitted to the St Agnes Hospital, September 17, 1926. The patient had fallen a distance of three feet from a ladder, landing on the heel. He walked to the hospital, where the diagnosis of fracture of the os calcis was made (Fig 3a). Under ether anaesthesia the fracture was reduced and the fragments nailed. Fig 3b shows the nail in position. A plaster case was applied and was removed in four weeks. About six weeks after the removal of the case he complained of pain across the tendo-Achillis. X-ray showed that the nail was loose, it was removed under local anaesthesia. There has been no further disability—the patient walks normally and suffers no pain.

FIG 3—Fracture of the os calcis. a, Showing the fracture. b, The fracture reduced and fixed by nail.

DR E B HONGL remarked that he had a case now at the Germantown Hospital for fracture of the os calcis. This case has been treated by the method which Doctors Jopson and Speese and the speaker have been using with satisfaction. This particular fracture is a badly comminuted one but the ordinary disability in these cases is due to the pulling up of the posterior fragment. The method of treatment is by tongs which pull the posterior fragment down so that the proper angle with the anterior portion is restored. The speaker did not think that this case could have been treated by nailing. Of course, the great disability comes from flattening of the foot, this method

of treatment has made it possible in almost all cases to bring the heel fragment down to its normal relationship with the rest of the bone

DR A. BRUCE GILL said that it is well known that fracture of the os calcis often produces prolonged disability. There are a number of conditions which cause this bad result or contribute to it.

The first one of these is the presence of spurs or a mass of bone on the plantar surface of the os calcis. This is due to the fact that the posterior fragment has not been reduced. On several occasions he has been obliged to cut off these spurs or masses of bone from the plantar surface and the result of operation has been satisfactory.

A second condition is a mass of bone on the external aspect of the os calcis. When the os calcis is crushed by a fall on the foot the inferior and superior surfaces are driven closer together and fragments of bone are forced out laterally. The patient complains of pain and tenderness just below and in front of the external malleolus over this mass of bone which is distinctly palpable and is also clearly shown in X-ray films. Why it should be the source of pain the speaker is not quite sure, whether because it contacts with the external malleolus on pronation of the foot, or makes pressure on soft structures as, for example, the sheath of the peroneal tendons, or, what Doctor Gill believes to be more probable, because it is at the outer aspect of the subastragalal joint and interferes with motion of the os calcis beneath the astragalus. This mass of bone presents a bone block to normal pronation of the foot beneath the astragalus. In two cases he has removed this mass of bone with very good result.

A third cause of pain and disability is a lateral displacement of the os calcis, usually to the outer side. At the time of reduction the fragments have not been replaced in their proper position beneath the astragalus. If they are displaced outward the patient has a talipes valgus and presents all the symptoms of a chronic flat foot. The same disability is produced as in a failure to reduce external dislocation of the astragalus in a case of Pott's fracture.

A fourth element in these cases of fracture of the os calcis is the involvement of the subastragalal joint in the fracture. Normal motion of this joint is interfered with by improper position of the os calcis beneath the astragalus or by new bone formation. Therefore motion is limited and it is apt to be painful. In these cases it is best to do a subastragalal arthrodesis to obliterate all motion between the os calcis and the astragalus. A little motion which is painful is much worse than an ankylosis of the joint. He had seen the same condition present in the ankle after Pott's fracture and had not hesitated to do an arthrodesis of an ankle-joint when there was not enough improvement obtained by more conservative means.

The speaker thinks that the method of reduction which Doctor Hodge employed is a very good one. Sometimes the fragments may be reduced by manipulation without the use of tongs or nail. If the knee is bent to relax the tendo-Achillis and if the foot is plantar flexed to bring the anterior

fragment of the os calcis in contact with the posterior fragment a good reduction can thus be secured. Some surgeons tenotomize routinely the tendo-Achillis. This is not very good surgery as in some cases it may be necessary later on to suture again the divided tendo-Achillis.

Possibly a contributing factor in the prolonged pain and disability which so often accompanies these fractures of the os calcis is the fact that fixation or support of the foot is not continued long enough. After the case or splint is removed the shoe which the patient is to wear should be fitted with a steel shank and with a felt pad to give proper support beneath the arch of the foot to prevent a sagging down of the os calcis at the point of fracture, before thorough union has occurred. Frequently, too, these patients have had even before injury a valgus or a certain degree of flat foot, and this condition of pronation or flattening complicates the case by throwing a strain on the foot which has now been further weakened by fracture.

In dealing with fractures of the os calcis one must bear in mind the complete mechanics and function of the entire foot. The speaker suspects it is largely the lack of a broad point of view on the part of the surgeon which sometimes contributes to these disabilities.

DR A. P. C. ASHURST remarked that he had never seen a good result in a fracture of the os calcis. Doctor Gill says he has seen two or three bad results, but the speaker has scarcely ever seen a good one. It is one of the most disabling of all fractures, especially when comminution is present involving the astragalo-calcaneum joint, in this type the results are bad in about 80 per cent of cases after ordinary treatment. For this reason Doctor Allison, of Boston, proposed, a year or so ago, to operate on all such patients at the time of injury, doing a subastragalar arthrodesis, and not to postpone this operation until the patient had passed through a long period of invalidism. The pain and disability which follows the injury is due to distortion of the upper weight-bearing surface of the calcaneum, rather than to changes on its plantar surface, though the latter may also cause disability. Doctor Allison has operated on more than twenty-five recent cases of fracture of the calcaneum in this way. About 85 per cent secured good function, and the average period of disability has been twelve weeks. It is therefore a method of treatment which demands attention.

DR JOHN A. JORSON said that he was not sure whether Doctor Speese or himself first used tongs traction in fracture of the os calcis. The method is a perfectly simple one. There may be other methods as good or better, but this fulfils the requirements and is simple of execution.

The knee should be bent and the best way is to put it in a Thomas splint with a bend at the knee. And then, as always when using tongs, one has to be careful of the landmarks and should not put the tongs in a position where they will do harm. In fracture of the os calcis, through the tuberosity, it is important that the tongs be in a proper position to make traction, also a small pair of tongs should be used.

The speaker demonstrated this method before the College of Surgeons and

Doctor Cotton, of Boston, who was present, stressed the importance of lateral moulding and manipulation to overcome the lateral displacement of

the main fragment or separate fragments—a point on which he lays great stress, with this modification he has continued to use the method and reports that it has proven very satisfactory

As in all fractures it is important to get the fragments down in position at the earliest possible moment

PULSATING EXOPHTHALMOS

DR THOMAS A SHALLOW reported the case of a man, age thirty-four years, who was admitted in the Jefferson Hospital, December 3, 1925, to the Ophthalmological Department of Dr William M Sweet. On admission this patient exhibited protrusion of both eyes, most marked in the right eye. In addition he complained of a headache accompanied by buzzing sounds. He gave a history of having been struck on the head November 7, 1924, while riding in an automobile. He was found unconscious some hours later lying in the road and was taken to a hospital in New Jersey. The unconsciousness lasted for twelve hours after he had been taken to the hospital. During the

FIG 1 —Showing the appearance of bilateral exophthalmos more marked in the left eye. At the time of this photograph no subjective bruit was heard

course of the unconsciousness and for four weeks thereafter he had a constant dripping of blood from the left ear

Six weeks after the accident he noticed that his left eye was turned

upward. This was in the latter part of December, 1924. Within a day or two after he had noticed the turning upward of the left eye, both of his eyes became prominent, the protrusion being more marked in the left eye (Fig 1). His vision was much impaired in the left eye. He was sent to a hospital in Philadelphia for this condition and a plastic operation upon the conjunctivæ performed. During the following months both eyes were very prominent and about equal in size. In August, 1925, the left eye began to very slowly recede.

In May, 1925, he noticed a peculiar humming noise in his head. This was aggravated on stooping and bending the head forward. He also complained of a peculiar noise in the left ear.

His first admission to the Jefferson Hospital was on December 3, 1925. Examination showed that both eyes were quite prominent, the right eye more so than the left. The conjunctivæ of both eyes was very redundant and chemotic. A well-defined continuous bruit was audible to the clinician over the right frontal sinus and over the right eyeball, and could also be heard indistinctly over the left frontal sinus. The bruit while continuous was accentuated during systole. The pupils of both of the eyes were dilated and reacted sluggishly to light.

Eye ground examination. Bilateral exophthalmos. The right eye protrudes 6 mm beyond the left eye. The optic nerve of the right eye is blurred at the edges and there is some hemorrhagic destruction of the retina. The veins are tortuous and the artery is small. The vision is 10/100. The left eye. The protrusion is not quite so prominent as of the right eye. Vision 20/40. The optic nerve is fairly healthy.

X-ray examination by Doctor Manges shows that the sella turcica is normal. There is no pathology in the bones of the skull to account for the exophthalmos.

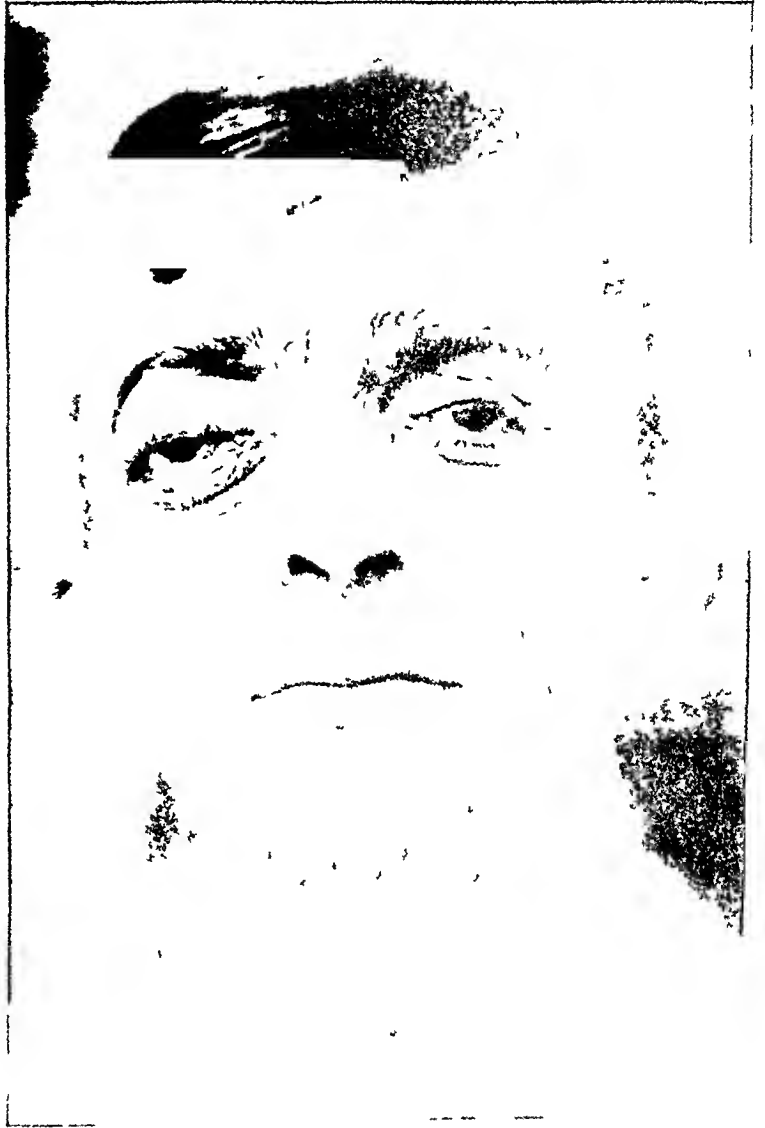


FIG 2.—Showing the recession of the left eye following ligation of the right common carotid artery and persistence of the exophthalmos in the right eye in spite of ligation of the right common carotid artery.

Medical examination by Doctor Thomas McCrae did not elicit anything in the patient's general physical condition to account for the exophthalmos

This case presented several unusual features. It is stated by writers that bruit is the first symptom of an arteriovenous fistula. This patient first complained of buzzing noises in his head in May of 1925, six months after the accident. On questioning his father after the death of the patient, it was learned that his son frequently asked him if it was raining because he thought he heard rain. This symptom disappeared after his discharge from the hospital. The patient himself stated positively that he did not have any noise in the head until May of 1925.

The next unusual condition in this case is a bilateral exophthalmos. There are cases on record of arteriovenous fistula in which bilateral exophthalmos occurred, but when it was noted in this case it began in the eye on the same side as the fistula and later extended to the other eye. The bruit could be heard and the thrill could be felt most strongly in the right eye. Dr. J. Chalmers DaCosta believed that the pathology was on the right side between the internal carotid artery and cavernous sinus. In this history

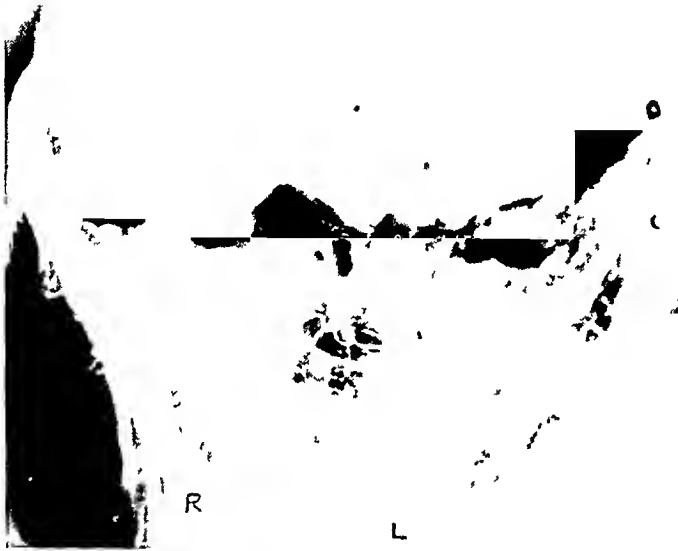


FIG 3—Showing aneurism between the right cavernous sinus and the internal carotid artery. The injection was made through the left carotid artery proving the reversal of the circulation through the circle of Willis into the aneurism. The reversal of current is the reason for failure of cure by ligation on the side of the fistula.

the left eye was the first organ to become prominent and remained more prominent than the right eye for a number of weeks. It is hard to explain how a lesion on the right side could be manifested first by exophthalmos on the left side unless it is assumed that the fistula is on the mesial side of the internal carotid artery in the region of the circular sinus and the stream of the current passes directly across the circular sinus to the left cavernous sinus and thence into the left superior ophthalmic vein, causing left-sided exophthalmos (Fig 1). After the pressure had risen sufficiently to practically cut off vision in the left eye. Within one week after the left eye protruded the right eye began to manifest exophthalmos. The examination of the patient made in December, 1925, over one year after the accident, showed a beginning subsidence of the left exophthalmos. It is to be recalled that Doctor Sweet stated in a previous examination that the right eye protruded 6 mm more than the left.

In spite of the manner of onset of this condition, that is the appearance first in the left eye, it was decided that the lesion was between the right internal carotid artery and the cavernous sinus, because of the location of the bruit on the right side, and, on January 8, 1926, the reporter ligated the right common carotid artery. Upon ligation, while the patient was still on the

PULSATING EXOPHTHALMOS

operating table, the bruit immediately ceased. From the time of the operation to January 24, there was a rapid diminution in the protrusion of the left eye and a more gradual diminution in the protrusion of the right eye. The patient did not complain of the bruit nor could one be heard by us over the right frontal bone. There was no palpable pulsation of either the right or the left globe.

On January 25, a very faint systolic bruit could be heard in the right eyeball. On January 31, this bruit was continuous and could be readily heard over the right frontal sinus. The right eye which had been receding became stationary and remained slightly exophthalmic. The left eye continued to recede.

An ophthalmological examination made February 28, showed that the left eye ground was almost normal and that the man was now able to read fine print. Right eye. Optic nerve was blurred at the edge and there was some exudate in the retina. Vision 10/100.

The patient was discharged from the hospital, February 28, 1926.

The patient was lost track of for a number of months. He came under observation again in November of 1926. The left eye was almost normal in size. The right eye showed decided exophthalmos. At this time he had a distinct thrill which would be felt in the superficial veins along the inner angle of the right orbit. A con-

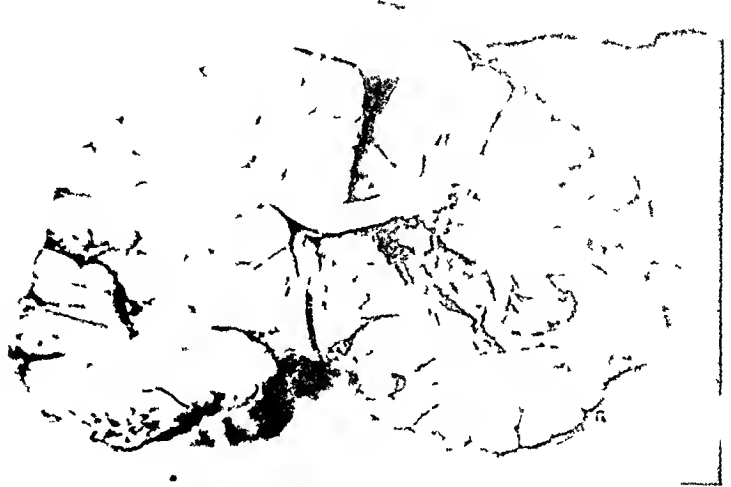


FIG 4—Showing the area of necrosis of the left hemisphere of the brain



FIG 5—Showing the distribution of the bismuth in all of the ramifications of the left common carotid artery in contrast to the almost imperceptible distribution of the bismuth on the right side except in the right internal carotid artery

tinuous bruit could be heard over the right frontal sinus and the right eyeball (Fig 2). There was a definite pulsation in the right internal carotid

artery It was thought at this time that the right common carotid artery had become cannalized and that the blood was passing through the right common carotid artery which had been ligated but not cut across. Closer observation did not disclose any pulsation in the right external carotid artery or any of its branches. It was concluded from that that blood was not passing into the right internal carotid artery from below nor from any collateral circulation established through the right external carotid artery. The presence of the blood in the right internal carotid was considered as due



FIG. 6 —Showing the enormous distention of the superior ophthalmic vein and its branches on the side of the fistula

to a reversal of current, the blood descending into the vessel (internal carotid) from the Circle of Willis. The blood was descending in the right internal carotid and not ascending. The patient was readmitted to the Jefferson Hospital to Doctor Sweet's service. Pressure on the left common carotid artery cut off the circulation in the right common carotid artery. Upon the release of this pressure the patient stated that objects were dancing in front of his eyes. This phenomenon continued for a second or two. In view of the

fact that the circulation could be cut off in the right internal carotid artery by compression of the left common carotid artery, ligation of the left common carotid artery was decided upon.

December 18, under ether anaesthesia, the left common carotid artery was exposed and drawn into the wound. A Crile clamp was applied to this artery. Through a stethoscope applied over the right frontal sinus and right eyeball, with the clamp in place, a very faint systolic bruit could be heard. No thrill could be felt in the superficial veins of the right orbit. In the right internal carotid artery there was no pulsation present. This proved conclusively that the current was reversed in the right common carotid artery. The reporter, therefore, ligated the left common carotid artery with the hope of curing the aneurism. Within two hours after the operation the patient became very restless and slightly irrational. No pulsation in the right internal carotid artery or the right external carotid artery could be felt. The bruit over the right forehead was very faint. No thrill could be detected in the region of the right eye. The patient developed on the third day weakness of the right arm and leg. He became comatose twelve hours before death and died six days after the ligation of the left common carotid artery.

Post-mortem Examination —The left common carotid artery was injected with a bismuth solution to determine the question of the route of the blood. An X-ray examination of the head was then made and it showed the bismuth in the left common carotid artery and in the aneurism, which was on the right

PURULENT PERICARDITIS IN CHILDHOOD

side and in the right common carotid artery (Fig 3) A very thin trickle of blood could be seen in the right external carotid artery The X-ray also disclosed that the right half of the brain was not injected with the bismuth throughout the course of the right internal carotid and its branches, and it was, therefore, concluded that the circulation had been reestablished through the anterior communicating branch over the anterior cerebral artery of the left side directly into the left common carotid artery Examination of the brain showed an area of softening in the left hemisphere in the region of the temporo-sphenoidal lobe (Fig 4)

The reporter concludes from this case that the surgical procedure in the treatment of traumatic arteriovenous fistula, associated with exophthalmos, should be the ligation of the common carotid artery on the side of the lesion When this procedure fails it is because of the development of reversal of current in the aneurismal sac and along the course of the internal carotid artery, the blood coming from the opposite side (Fig 3) Any further surgical intervention should be limited to ligation of the superior ophthalmic vein on the side of the lesion (Fig 6) Ligation of the opposite common carotid artery being unjustifiable because of the likelihood of necrosis and subsequent softening of the brain on the side of the last ligation (Fig 4) and because of the great diminution of circulation in the vessels of the brain on the side of the first ligation as shown in this case by the X-rays (Fig 5)

FURTHER OBSERVATIONS ON SPINAL ANÆSTHESIA WITH ANHYDROUS COCAIN IN 500 CASES

DR J RALSTON WELLS read a paper with the above title, for which see p 757

DR J S RODMAN called attention to two points which seemed to be of more interest than others One of the great difficulties about cocain has been its toxicity, but apparently Doctor Wells by his present method has been able to largely overcome that difficulty The other point brought out was the fact that cocain was the only anæsthetic that sought out the sensory nerves alone The speaker had a rather unpleasant experience once with stovain, one patient developed bladder paralysis for about ten days and another developed partial paralysis of the lower limbs for one week This had made him cautious about the use of stovain Doctor Wells has given this type of anæsthesia for the speaker in twelve cases and it has proven very satisfactory Doctor Rodman feels that it has reached the point where it is safe to use it when indicated

PURULENT PERICARDITIS IN CHILDHOOD

DR ERNEST G WILLIAMSON read a paper with the above title, for which see p 659

DR JOHN H JOPSON asked that Doctor Williamson include in his series another case from the Children's Hospital in which the speaker drained the pericardium for suppuration but failed to save the child's life

DR J W BRANSFIELD remarked that he had presented a patient before the Academy two years ago, who had a suppurative pericarditis following a stab wound He resected two ribs at the costochondral junction The patient made an uneventful recovery

PHILADELPHIA ACADEMY OF SURGERY

DR J S RODMAN said that ligation of the internal mammary artery is now a routine procedure in pericardiotomy but that in one case, some years ago, he failed to do this and lost the patient from secondary hemorrhage, the patient dying before anything could be done. This patient had pyæmia in addition to the pericardial infection.

DR A P C ASHHURST mentioned a case, the only one of its kind he ever encountered. In December, 1924, a boy ten years of age, was treated at home by a practitioner who thought the child had a pericardial effusion, he called as consultation a specialist, who introduced a needle, but got nothing, the puncture was repeated three times, and got nothing until the fourth puncture, when blood was obtained. The consultant then withdrew the needle and retired from the case. The patient immediately became much worse, and was brought to the hospital the next day, by the family physician. There were the usual signs of massive pericardial effusion, and severe secondary anæmia. It was evident that the child had been bleeding into the pericardium. Under local anæsthesia an incision was made and the pericardium found full of old and disorganized blood, which was ejected in violent spurts. The patient improved as the blood flowed, and after nearly two litres had been evacuated the pericardium seemed dry. There was no bleeding from the heart at this time, presumably the pressure of the pericardial contents had allowed the puncture of the heart to heal. A rubber catheter (No 16) was left in the pericardium as a drain. The child, who had seemed almost moribund before operation, was remarkably improved on return to bed, and asked for some ice-cream. The next day, however, he gradually failed, there was no bloody drainage, but death (which occurred thirty hours after operation) seemed due to secondary anæmia.

After death the wound was explored by Doctor Hicks, the ward surgeon, who found a little bloody serum in the pericardium, and the heart contracted in systole.

DR HENRY P BROWN said that when the correct diagnosis of suppurative pericarditis is not made, it is usually because it has not been considered. The incision should be made in the lower part of the pericardial cavity. It should be borne in mind that the diaphragm is usually one rib lower in the adult than in the child. The sinus must be kept wide open, a free incision into the pericardium with adequate tube drainage is the best, the edges of the pericardial incision being sutured to the muscle or skin. The case reported by Doctor Williamson developed a sterile effusion in the right pleural cavity, which cleared up after three aspirations. The reason for the development of this collection could not be discovered.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held January 26, 1927

The President, DR WALTON MARTIN, in the Chair

CARCINOMA OF JEJUNUM

DR CONSTANTINE J MACGUIRE, JR, presented a woman, forty-two years of age, who was admitted to St Vincent's Hospital, March 20, 1916, suffering from pain in the epigastrium immediately after meals, eructation of gas and bitter fluid, occasional vomiting, loss of twenty-five pounds of weight in nine months. The onset had been two years previously when the patient felt pain in the epigastrium, temporarily relieved with diet and bicarbonate of soda, but for a year there had been progressively increased constipation, pain and vomiting.

Gastro-intestinal X-ray series showed impairment of gastric motility, considerable deformity of the duodenal bulb and a definite deformity of the third portion of the duodenum which did not at any time fill out normally. Other laboratory findings were negative except acetone in the urine.

The patient was kept on a Sippy diet which failed to relieve her symptoms so, on April 15, 1926, she was operated upon with the following findings:

About five inches from the duodeno-jejunal angle there was a mass involving the jejunum, transverse mesocolon and the posterior surface of the transverse colon. At this point the jejunum was acutely angulated. The mass was not attached to the posterior abdominal wall and was freely movable. It was hard, nodular and about 6 cm in diameter. Retroperitoneal nodes at the root of the mesocolon and mesentery were palpable. No metastases were felt in the liver. The stomach showed no evidence of ulceration. Periodically, there would be a contraction of its entire length, reducing its diameter by half. On separating, by blunt dissection, the jejunal mass from the transverse mesocolon it was found that there had been two openings in the jejunum protected only by the mesocolon and the posterior surface of the colon, so that after dissection the lumen of the jejunum was exposed in two places, not as result of dissection, but because of an old chronic process.

The involved portion of the jejunum was excised well beyond the diseased area, proximally and distally, and an end-to-end anastomosis of the jejunum performed. This left the anastomotic line within one inch or so of the duodeno-jejunal angle.

Pathological report by Doctor Culphey of the excised specimen is as follows:

Specimen consists of length of small intestine measuring 10 cm. The wall is held rigid in its central portion by the presence of an annular tumor mass extending up and down the gut for a distance of 4 cm. Section through the mass shows opaque white homogeneous tissue with evidence of superficial ulceration of that part directed toward the lumen. Sections show sheets of undifferentiated epithelial cells having large oval hyperchromatic nuclei, many showing mitosis lying for the most part in the mucous and submucous coats, but also infiltrating the muscle to a lesser extent. Numerous plasma cells, lymphocytes and eosinophiles are present in the muscular coats and lie also

among the tumor cells in the inner coats of the gut Medullary carcinoma of jejunum

Recovery was uneventful and has been followed by complete relief of subjective symptoms up to present

This case is presented because of the rarity of the condition Ewing in his text-book says that the small intestine is the primary site of about 3 per cent of intestinal cancers, but at Bellevue Hospital in a recent analysis of about 600 deaths from cancer in a total of 1700 autopsies there was not a single case classified as carcinoma of the jejunum

DR DEWITT STETTEN said that he had never seen a case of carcinoma of the jejunum, but that he had seen a carcinoma very close to the jejunum, namely in the transverse duodenum Some years ago he had been asked by the Medical Service of the Lenox Hill Hospital to operate on a man suffering from jaundice A presumptive diagnosis of either cholelithiasis or carcinoma of the papilla of Vater or head of the pancreas had been made The patient was given a dose of castor oil in preparation for the operation on the following day, and developed a severe gastric and intestinal hemorrhage No operation was performed and the patient died within forty-eight hours Post-mortem examination showed an extensive carcinoma of the transverse duodenum

RECURRENT ULCER OF JEJUNUM

DR CONSTANTINE J MACGUIRE, JR, presented a man who was admitted to the First Surgical Division of Bellevue Hospital, December, 1923, suffering with a duodenal ulcer Posterior gastro-enterostomy was performed, giving entire relief for nine months when pain and tenderness recurred, but this time it did not come on until five hours after meals and was situated above and to the left of the umbilicus X-rays showed an ulcer of the jejunum, and in May, 1925, a second operation was done He resected the jejunal ulcer, removed all the stomach from a point proximal to the gastro-enterostomy and including the first portion of the duodenum The jejunum had been divided in resecting the ulcer so the distal aim of the jejunum was anastomosed to the open end of the stomach and the proximal jejunum planted in the distal loop lower down This procedure gave relief for only three months when pain again developed Subsequently there were several severe hemorrhages from the stomach, blood count showed only 2,400,000 blood cells, with 40 per cent hæmoglobin Careful and prolonged treatment by alkalies, bismuth, rest in bed and careful regulation of diet gave no relief In May, 1926, he was shown to this Society as a very unsatisfactory result after extensive resection No definite therapeutic measures were suggested at that time In June, 1926, the patient was so miserable and incapacitated that he consented to a third operation which had been advised with some trepidation because of the man's marked anemia and also because of the technical difficulties As regards the latter, he was not disappointed as the adhesions were very dense and troublesome The anastomosis between the stomach and jejunum was oedematous and indurated with extensive ulceration of the mucosa at the lower angle The gastro-jejunosomy was excised *en masse* with the efferent loop of jejunum down as far as the jejuno-jejunosomy and the continuity of the gut at this point was restored A loop of jejunum about eight inches distal to this was brought up and anastomosed to the stomach by the posterior Polya method The patient made a good recovery and since his discharge has been free from untoward

CARDIOSPASM

gastric symptoms and has steadily gained weight and strength so that he is able to resume all his duties as Captain of a Barge. A recent gastric analysis showed total acidity 45, free HCl 25. At the time of his first admission gastric analysis showed total acidity 90, free HCl 75. His case is shown as demonstrating the following points:

- 1 Failure of subtotal gastrectomy to control acidity
- 2 A modified Polya operation using method recommended by Moynihan was followed by an extension marginal ulceration. It seems logical to conclude that the alkaline duodenal contents passed on below through jejunojejunostomy and left the anastomotic aim above unprotected from the full effect of the acid gastric secretion thus indicating a grave physiological error in the operation.

DR RICHARD LEWISOHN remarked that the patient had recurrent ulceration such a short time after a sub-total gastrectomy. Doctor MacGuire performed the sub-total gastrectomy according to the method of Roux "en Y". Although Moynihan uses this method to the exclusion of all others and reports good results, Haberer has reported recurrent ulcers following this method. Another interesting point was that it was never possible to establish in this patient complete absence of free hydrochloric acid. It is still a mooted question whether or not there are differences in the location of the acid glands in different stomachs. In investigating the cases of sub-total gastrectomy at Mount Sinai Hospital it was found that in all cases of gastric ulcers, achlorhydria had been established, whereas in duodenal ulcers only 66 per cent showed absence of free hydrochloric acid.

DOCTOR MACGUIRE, in closing the discussion, said that at Bellevue Hospital their choice of method in gastric surgery was frequently forced by circumstances and they had not yet been able to take any definite stand for or against the radical school. It seemed to him that this problem must always be a physiologic one. They were obliged, however, to do many sub-total gastrectomies because of mechanical factors.

CARDIOSPASM

DR ALLXIS V MOSCICOWITZ presented a man, now forty-seven years of age, who was referred to him in November, 1924, with a history of slowly increasing difficulty with deglutition, which began about ten years ago, so that at the time of his first visit he could swallow only liquids, and even that with considerable difficulty and with frequent regurgitation. He had lost considerable weight, and quite naturally a tentative diagnosis of a carcinoma of the cardiac end of the stomach was made. X-ray examination showed a stricture of the cardia. He was œsophagoscoped by Doctor Yankauer, who did not find a tumor. The patient refused operation at this time. Subsequently, the difficulty with swallowing increased so much that by the early part of March, 1925, he could not swallow even fluids.

The X-ray examination in November, 1924, showed a thin stream of bismuth passing through the cardia. The X-ray examination just before the operation failed to show bismuth passing through the cardia and a stomach tube was also arrested completely at the cardia.

March 4, 1925, he was operated upon by incision through the upper part of the left rectus. The stomach was withdrawn from the abdominal cavity and

an incision made upon its anterior surface sufficient to admit the hand. It was rather difficult to find the cardia from the gastric side, but was finally accomplished. It at first barely admitted the tip of a finger, but subsequently was dilated until it easily admitted four fingers. The gastric incision was now completely closed.

In view of the bad history, he was afraid to leave the patient in this condition and therefore added in another part of the stomach a gastrostomy, which was performed by the Kader method.

Feeding, at first liquids, gradually increasing to solids, was begun on the third day after operation and patient has been able to swallow without difficulty ever since that time. From time to time when the bolus is very large, he has to wash it down with a little water.

The patient subsequently changed his gastrostomy tube and inadvertently was given one much larger than the customary one. When Doctor Moschcowitz was ready to permit closure of the gastrostomy, the opening was so large that it failed to close. Since then the opening has contracted until it is now barely visible, although it occasionally leaks a drop or two even now.

The patient has gained about sixty pounds and is now in excellent condition.

OSTEOMYELITIS OF THE PUBIC BONE

DR ALEXIS V MOSCHCOWITZ presented two cases as follows:

CASE I—A man forty-nine years of age, was admitted to Mt. Sinai Hospital the first time, July 2, 1922, complaining of pain in the perineum of five days' duration. He gave the following history: Five days prior to admission, the patient who is a machinist, inadvertently sat on the point of an oil can and caused thereby a punctured wound of the perineum. The injury was followed by hæmaturia which lasted two or three days. He was treated conservatively, at first, although a blood culture taken July 4 and 8 revealed the presence of four colonies of staphylococcus aureus, but the infection progressed more and more, and finally, sixteen days after admission an enormous abscess which surrounded the rectum was evacuated. He was discharged September 19 with a long sinus, into ambulatory treatment.

The sinus failed to heal and he returned to the hospital, November 8, 1926, at which time there existed several sinuses in the perineum and scrotum. These sinuses intercommunicated and when injected with lipiodol and X-rayed showed numerous ramifications, and a suspicious osteomyelitis of the pubis.

He was operated upon November 18, 1926, a liberal incision was made and when explored, the wound was found to lead to the posterior surface of the pubis to a sequestrum which was very readily removed, although with some difficulty because of its location. With the exception of a rather intractable dermatitis, he made an excellent recovery and was discharged December 27, 1926.

CASE II—A man was admitted to the hospital in February, 1921, complaining of fever of nine days' duration. He gave a history of having had an infected finger three weeks previous to the onset of his present illness, which was accompanied by chills and fever. His physical examination showed a tender left lobe of the prostate with infiltration of the surrounding tissues. A blood culture taken at that time, showed on two occasions two colonies staphylococcus aureus per c c blood. The temperature was of the septic type.

He was operated upon by Dr. A. Hyman, perineal section and evacuation of a large abscess in the region of the prostate extending upward on the left side of the pelvis. Subsequently, various perirectal and rectal collections of pus, as well as a large abscess on the right side of the thigh were evacuated. He was discharged in May, 1921, with various sinuses which intercommunicated.

EXCISION OF RIGHT SUBCLAVIAN VEIN FOR BACTERIÆMIA

In this condition, he was admitted to the service of the reporter in October, 1921, with various sinuses as above stated. The X-ray examination at this time revealed a sequestrum in the ascending ramus of the left pubic bone. He was operated upon through an incision three inches in length over the left half of the symphysis pubis and an opening made into the pubic bone. A sequestrum one-half inch by one-quarter lying in a cavity of unhealthy granulations in the centre of the bone, was removed. The entire wound was packed wide open. The post-operative course was most satisfactory and in a few weeks all of the perineal, pubic and thigh wounds were closed, so that the patient was discharged perfectly well in February, 1922.

The third admission was October, 1926, when the patient complained of pain and swelling at the site of the old perineal wound. After temporizing for a while, an abscess formed which was incised and drained. The examining finger felt an area of bare bone at about the junction of the descending ramus of the pubis with the ascending ramus of the ischium, but it evidently covered over as the wound completely healed in three weeks' time.

EXCISION OF RIGHT SUBCLAVIAN VEIN FOR BACTERIÆMIA

A man twenty-eight years of age, was admitted to Mt. Sinai Hospital, December 16, 1926, with a history that about six weeks prior to his admission, he had a boil or an abscess about the middle of the right axilla. This abscess was incised about one week later by his attending physician, who dressed the wound for about a week and advised that the patient dress it himself. Shortly thereafter, the patient began to complain of pain in the supraclavicular as well as suprascapular region. On the day before admission to the hospital, he had a chill and a rise of temperature, when admitted, his temperature was 103.

The physical examination revealed in the right axilla, a reddened, not particularly tender area about the size of a 50 cent piece, in the centre of which, there was a small opening which admitted a probe to an inconsiderable distance. Glands could be palpated high up in the axilla and in the supraclavicular fossa.

A diagnosis of a subpectoral abscess was made, a blood culture was taken and the sinus in the axilla enlarged so as to admit exploration. No true subpectoral abscess was found, but all of the glands were found to be œdematous.

The following day, the patient felt somewhat better, but complained of pain and tenderness, particularly in the right supraclavicular fossa. The temperature fell slightly.

December 18, the swelling of the neck and tenderness in the right supraclavicular fossa had increased. The blood culture taken December 16, was reported to contain Gram-positive cocci in chains and bunches. (There was some argument about the presence of bacteria at this time in the culture, but the final result proved to be positive.) This morning, the patient had a chill and rise of temperature to 105.2. The axillary wound was revised so as to expose widely the subpectoral space by a complete division of the pectoralis major. Nothing more than œdema and swollen glands was found.

When the infraclavicular portion of the subclavian vein was exposed, it looked grayish-white and infiltrated and did not empty and fill with respiration. He therefore divided the clavicle and subsequently, in order to gain space excised about three inches. The internal jugular vein as well as the terminal $\frac{1}{2}$ inch of the subclavian vein was normal and flaccid. A catgut ligature was now placed around the subclavian vein at its junction with the internal jugular vein. The subclavian vein was aspirated with a fine hypodermic needle and cultured. This showed both in culture and smear, streptococcus viridans. The

vein was now excised downward and upward, until a healthy part of the axillary vein was encountered. The cephalic vein and all the other branches were ligated as encountered. The excised vein showed on pathological examination a phlebitis, periphlebitis with an organizing parietal thrombus. The divided pectoralis major was sutured and a liberal rubber dam drain inserted.

After the operation, the temperature fell abruptly to 99, but on the following day, December 19, the temperature rose again to 104.6, there were no further chills, however, and the temperature fell by lysis and reached 100 in three days.

There was considerable infection of the wound, but the patient made a very excellent recovery. At no time was there more than a passing and barely noticeable oedema of the hand and arm.

He had not been able to examine the literature more than casually, but this superficial examination failed to reveal a case of extirpation of the subclavian vein for sepsis.

DR DEWITT STETTEN considered this a most remarkable case, the results of which have given him courage to undertake this step himself in similar cases. It has especially shown him that there is no need to worry about subsequent circulatory disturbances in the upper extremity. Some years ago he had a case of septic phlebitis of the axillary vein and probably the subclavian vein following a rather insignificant infection of a finger with a secondary epitrochlear abscess. Consultation was held with Dr Joseph A. Blake and the question of ligating the axillary or subclavian vein was very seriously discussed, but the idea was finally abandoned. The child later developed a streptococcic empyema and died.

DOCTOR MOSCHCOWITZ, in closing the discussion, spoke of a case he had a few years ago, very much like the one reported by Doctor Stetten. The patient had a suppurating epitrochlear gland. When this was operated upon a thrombosis of the brachial vein was seen. The incision was therefore extended upward and the vein ligated, apparently above the site of the thrombus. The patient developed a bacteraemia with a positive blood culture. Doctor Blake was called in consultation and the question of ligating the axillary or subclavian vein was discussed, but was not done because of lack of courage. The patient died.

CHRONIC HYPERTROPHY OF THE STOMACH WITH A REPORT OF TWO CASES AND WITH A DISCUSSION OF LINITIS PLASTICA

DR KIRBY DWIGHT read a paper with the above title for which see page 683.

DR HENRY H. M. LYLE said that in studying the subject for his paper on linitis plastica (*ANNALS OF SURGERY*, November, 1911), his impression was that this condition of the stomach is very often a local manifestation of a general sclerotic process. Many of his cases had lesions elsewhere and not a few were associated with adhesive peritonitis. A large per cent of the autopsies showed an associated cardiac disease and other connective tissue lesions throughout the body. His own patient, operated on in 1907, had a very marked cardiac condition and finally died from it.

CHRONIC HYPERTROPHY OF THE STOMACH

DOCTOR LYLE at this time wrote to Professor Welch regarding his views on the benignity of this lesion and in a personal communication, Professor Welch expressed his relief that there was a benign lesion, stating, however, that many of the cases of so-called linitis plastica were malignant.

DOCTOR LYLE has been following this subject closely since 1907 and is thoroughly convinced that there is a true linitis plastica which is benign in nature.

DR JOHN A. MCCREERY presented a specimen of a case of linitis plastica (Figs 1 and 2) as he believed it had a bearing on Doctor Dwight's paper. Patient was admitted to Bellevue in December, 1926, a woman forty-three years old, with a history of loss of appetite and loss of strength extending over a period of two and a half years. For a few weeks previous to admission there had been epigastric pain coming on shortly after meals and accompanied by vomiting.

The patient was a well nourished adult woman who showed evidence of moderate loss of weight, but who was not cachectic. On physical examination a firm cylindrical mass could be



FIG. 1.—Specimen of linitis plastica transverse section, note attached spleen.

felt extending the epigastrium. This was considered to be the pyloric portion of the stomach. X-ray revealed a markedly contracted stomach with a very narrow lumen through which bismuth passed without peristaltic action. The œsophagus was dilated. A pre-operative diagnosis of linitis plastica involving the entire stomach was made and confirmed at operation. A complete gastrectomy following the method outlined by Moynihan was done, the spleen being removed with the stomach because a contracted and thickened gastro-splenic omentum made this the easier procedure. The immediate post-operative reaction was satisfactory, but four days after operation the patient developed signs of a pulmonary infarct and died twelve hours later.

Autopsy showed a complete obliteration of the subclavian vein. Histologically this proved to be an organized thrombus. Emboli were found in the pulmonary vessels supplying the infarcted lung. There was no evidence of malignant disease except at the lower end of the œsophagus where microscopic evidence of carcinoma was found. The anastomosis was intact, but there was a small amount of peritoneal exudate about it. Examination of the stomach revealed a cylindrical organ measuring 18 x 4 cm. The lumen held 12 c c

The wall of the stomach was thickened to an average of 1.5 cm, apparently by a fibrous tissue thickening of the sub-mucosa and muscularis. The mucous membrane was intact throughout. Microscopically there was a marked fibrous tissue thickening of the sub-mucous and muscular layers while the sub-mucosa was diffusely infiltrated with an undifferentiated embryonal type of epithelial cell. This malignant change extended into the oesophagus beyond the line of division. The adjacent lymph glands showed two different types of involvement, in some the lymphoid tissue was in part replaced by broad branching strands of epithelial cells, while others presented only a few scattered epithelial

cells buried in fibrous connective tissue and fat which had replaced the normal lymphoid structure.

DOCTOR MCCREERY presented this specimen as of interest in connection with Doctor Dwight's paper. He thought that this was a case of generalized linitis plastica of malignant origin, one of the cases of which Ewing spoke, of a recessive type of carcinoma with a slow growth rate and with a



FIG. 2.—Specimen of linitis plastica external appearance.

high resistance on the part of the patient. The varying pictures in the lymph glands were of particular interest, showing the attempt to localize and destroy the epithelial cells by the development of surrounding fibrous tissue.

DOCTOR DWIGHT, in closing the discussion, agreed with Doctor Lyle that there were undoubtedly various and different causes for a condition of the stomach, in appearance identical with linitis plastica. It is entirely a question of definition. The present tendency to narrow the meaning of the term to that of malignancy is perhaps to be regretted, for as a consequence there is a decided trend toward the merging of linitis with the other forms of diffuse carcinoma of the stomach. Also the non-malignant cases of diffuse thickening of the stomach wall have lost the name under which they have been classified in the past, and there is now a tendency to overlook them. Some of these benign cases may be the effect of a constitutional disturbance, as those in which there is, coincident with the gastric condition, some disease of the heart, or those in which there is a multiple linitis of the stomach and various parts of the large or small intestine. Ewing considers that this latter condition may be an example of polyserositis, but it must not be forgotten that certain of them have been proved malignant.

BRIEF COMMUNICATION

TRANSTHORACIC ABDOMINAL HERNIA

H. L., man laborer, aged thirty-five entered Barnes Hospital in July, 1926, complaining of a painful lump in the left chest. His family history was irrelevant. He had been in the German army during the late war and had been wounded several times, but never in the chest or abdomen. Five years ago he had had a severe acute illness with fever lasting two weeks. At the end of this time he was operated on for a "subphrenic abscess" on the left side. He was in the hospital for three months and was incapacitated for another month. There was no cough associated with this illness. Three years ago there first appeared a bulging in the region of the operative scar on the left chest. This has gradually increased in size. It has given no symptoms until about three weeks from the date of entrance, at which time following a muscular strain during heavy work it began to cause pain severe enough to make the patient seek relief.

The patient had been studied in the Washington University Dispensary and in the Chest Service of the Barnes Hospital by Doctors J. J. Singer and D. S. Allen and was sent into the hospital for surgical treatment.

Physical examination was negative except for the findings in the left chest. All the routine laboratory examinations gave negative results. In the posterior portion of the lower left axilla was an oblique linear operative scar about eight inches in length. A hernial mass about six inches in diameter was crossed by this scar. Palpation revealed a bone defect involving the eighth and ninth ribs for a distance of about six inches. This formed the border of the neck of the sac. The mass itself varied in consistency. At times gurgling of air could be felt, and at others, the sharp edge of a presumably solid organ. The patient was able to increase the size of the hernia by forced expiration with the mouth and nares closed. Physical examination of the chest and abdomen showed no abnormality. The level of the diaphragm showed no alteration. Fluoroscopic examination, after the introduction of lipiodol in the left lower lobe, showed the lung to be normal and not connected with the hernia. It was thought at first that the mass felt in the hernia might be a compressed lung.



FIG. 1.—Photograph showing hernia and old operative scar. The patient is increasing intra-abdominal pressure by forced expiration with mouth and nares closed.

BRIEF COMMUNICATION

Rontgen-ray plates included (a) plain plates (Fig 2), (b) lipiodol outline of the bronchial tree (Fig 3). The first showed a solid organ in the hernia. The second showed that the lung tissue apparently did not enter the hernia. It also showed an air-containing viscus in the hernia with an outline suggestive of colonic haustration. In none was an abnormal level of the diaphragm made out until compared with the post-operative plate. Negative pyelogram and gastro-intestinal contrast examinations were also made.

Operation—July, 1926. General anæsthesia. The incision embraced the sear over the hernia. The skin was dissected back. The dissection was carried through the sear



FIG 2—Radiograph showing solid organ (spleen) in the hernia. Pre-operative. (The outer line indicates the outline of the skin and the inner line the outline of the spleen, as seen on the original film.)

mattress sutures of chromic catgut were placed in the capsule of the spleen, and in the innermost of the two layers, and the spleen was thus firmly united to the upper margin of the ring, forming a tampon for the hernial opening. The upper and lower angles were not satisfactorily closed by this manoeuvre. The union of the spleen to the bony ring was reinforced by the second of the two layers, which was sutured across the opening.

The entire hernial orifice was then interlaced in every direction by sutures taken from the fascia lata using the Gallie technic. The weak angles were particularly strongly reinforced.

The muscle masses of the back were united by two layers of interrupted chromic catgut sutures. A continuous silk suture was used to close the skin.

until the bony margin of the ring was exposed and the peritoneum reached. This was stripped back from the upper margin of the ring until apparently normal fibres of the diaphragm attached to the seventh rib were exposed. In other words, the diaphragmatic attachment had been lifted at least four ribs. No defect in the diaphragm could be seen or felt. The pleural cavity was not entered. An attempt was then made to open the peritoneum. This was successful, after considerable difficulty, at the inner lower angle of the wound. It became obvious that the hernia was of a sliding type involving the attachment of both the splenic flexure and the thickened adherent spleen.

The free edge of the lower peritoneal fold was then imbricated under the upper fold and the latter tacked down over the former. Two incomplete layers of sear tissue could be dissected free at the upper margin of the bony ring. Interrupted

TRANSTHORACIC ABDOMINAL HERNIA

The result seemed to be a firm wall. Transplantation of a rib was considered and discarded on account of an apparently satisfactory result.

The post-operative course was smooth. The patient was discharged on the fifteenth post-operative day.

The patient has been seen from time to time. He has worked intermittently since discharge. He was last seen on January 25, 1927, six and one-half months after opera-



FIG 3—Radiograph showing lipiodol outline of bronchial tree and air-containing organ (colon) in the hernia. Pre-operative

tion. Examination showed firm closure of the hernial orifice except at the upper posterior angle where there was slight bulging over an area one and one-half inches in diameter on forced expiration. Radiograph at this time showed clearly the abnormal attachment of the diaphragm.

Although this may well be a unique case, yet the unusual nature of the hernia makes proof of this point difficult. It cannot be classified as a diaphragmatic hernia under the usual definition of the latter as a hernia *through* the diaphragm. Certainly search through recent literature on diaphragmatic

BRIEF COMMUNICATION

hernia reveals no similar case. It is obvious, therefore, that a difficulty of nomenclature exists. The term used—transsthoracic abdominal hernia—seems to describe the condition clearly.

The most interesting pathological observation is the transplantation of the thoracic attachment of the diaphragm upward from the eleventh rib to the seventh rib. The patient's name for the primary condition ("sub-phrenisches Abzess") was given with no hesitation or suggestive questioning. Certainly the absence of scar tissue among the diaphragmatic muscle fibres was striking.

From the diagnostic viewpoint, the use of lipiodol insufflation of the bronchial tree to demonstrate the absence of lung tissue in the hernia is of the greatest interest. This method of examination is being used more and more freely in this clinic and elsewhere. This perhaps is a unique application.

The case further illustrates the refinement in diagnostic possibilities in thoracic disease by employment of newer methods, particularly under the favorable conditions created by close medical and surgical cooperation.

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CHANGE OF EDITORIAL ADDRESS

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TRAUMATIC CYANOSIS—ITS PATHOLOGICAL PHYSIOLOGY

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OF DETROIT, MICH

FROM THE SURGICAL SERVICE OF HARPER HOSPITAL

TRAUMATIC cyanosis, or asphyxia, is a phenomenon produced by the suspension of respiration for a time, due to enforced compression of the thorax or thorax and abdomen. This results in a purplish discoloration or cyanosis of the head and neck and in subconjunctival hemorrhages. There is, of course, a generalized reaction which may or may not terminate in death. The number of these cases studied in life is very small and most of those living for a time after the injury was sustained, recovered. However, contrary to Green's statement that most cases recover, this statement should be limited to the cases studied in life, for there are many reports of cases dying with this syndrome after crushing injuries sustained in panics and mobs. In fact, the first to report the syndrome was Ollivier, who reported twenty-three cases crushed to death in the Champs de Mars crowd (June 14, 1837). The peculiar discoloration of the face and neck was found in all of these cases. Autopsies on nine of these cases showed no cerebral hemorrhages. The blood was black fluid, and filled all the veins running into the heart. Punctate hemorrhage occurred into the loose tissues of the scalp on the surface of the pleura, pericardium, heart and abdominal viscera. There was extravasation of blood under the conjunctivæ.

From the crowd of the Pont de la Concord there are nine cases of this syndrome reported by Tardieu (1870).

The following is a brief report of a recent case, No 2059 (1926), at the Harper Hospital of Detroit.

History—A single, white, Polish laborer, thirty years of age, was received at the Harper Hospital, February 15, 1926, as a traumatic emergency. A short time before entry he was compressed against a stone wall by a steam shovel. He was relieved from his predicament very quickly and brought at once to the hospital.

Except for a crushing injury to his left lower leg (requiring amputation), two years ago, the patient had always been well and without complaint.

The man was a very well-developed and nourished young white male, in great pain and in shock. His face, neck and the upper part of his shoulders were literally as blue as indigo, but the remainder of the body, although not of good color, was not so remarkable. There were extensive subconjunctival hemorrhages in both eyes. The cyanosis paled slightly on pressure.

Neck—Very blue to the clavicular lines.

Chest—Great pain in upper right chest in front, with tenderness. There was a bony irregularity of second to fifth ribs on the left—an area being raised above the level of the rest of the thoracic cage. There was a slight amount of subcutaneous emphysema lateral to this area.

Lungs—There were fine, crepitant râles heard all over the right chest in back. No other abnormalities of voice or breath sounds or percussion except the area over the bony irregularity which was not percussed because of great tenderness.

Heart—No apparent displacement. No increase in size. Sounds clear and of good quality. No murmurs or thrills. Rate 140 per minute. Pulse of fair volume and tension.

Abdomen—Generally resistant, but no tenderness.

Pelvis—There was tenderness and pain on pressure over the bony pelvis.

Extremities—Left leg amputated (old) below knee.

There was a large bony protuberance posteriorly in the region of the left scapula. This appeared to be the acromial process of the clavicle which was displaced backward.

Treatment and Progress—Patient was given oxygen, morphine gr $\frac{1}{4}$, the morphine repeated in an hour, heaters and blankets were applied, atropine gr $\frac{1}{150}$ and caffeine sod. Benz. gr viiss were given. Fluids were given by mouth.

The patient's pulse was up to 140 and thereabouts for the first four days, and then gradually declined to normal. His temperature reached 102.2° on the third day, and gradually declined to normal. The respirations were between 28 and 40 for the first nine days and then gradually reached 20 and remained there.

X-ray showed a double fracture line in the inferior ramus of pelvis with a displacement of the fragments at the inferior fracture. There was a fracture of the superior ramus well posteriorly. A film of the chest revealed some clouding of the right lung field. There was some evidence of fracture of the second rib at the lateral chest wall. The left lung was not collapsed. A film of the left shoulder showed elevation of the distal end of the clavicle but no fracture.

Except for morphine, and later codein, aspirin and sodium bromide, the treatment was limited to complete rest, strapping of chest, until March 27, when an open operation for reduction of the clavicle was undertaken under nitrous oxide-ether anaesthesia.

The patient's general condition continued to improve slowly, and he was discharged on April 17, 1926, the sixty-third day. His remarkable cyanosis of the face and neck and upper shoulders still being evident but not so marked, and all but a trace of his subconjunctival hemorrhage having disappeared. At no time did the cyanosis change to the green and yellow color associated with extravasated blood forming the bile pigments.

Word from Doctor Naylor who saw the patient two months after discharge is that the cyanosis had completely cleared up, and the conjunctivæ were normal except for a muddy appearance.

There are certain considerations in regard to this syndrome which are well illustrated by this case.

The type of injury usually is as here, a crushing injury of the chest or of the chest and abdomen, causing a cessation of respiration. The chief causes of this injury have been crowds or panics, elevator accidents, injuries by trains or other vehicles. The clinical characteristics are: The color of the skin of face, head and neck, which varies from "dark red to purple." It is described both as discrete and confluent. It is reported as extending down as far as the third rib on the chest and in back to the level of the lower border of the trapezius muscle.

Subconjunctival hemorrhages are common.

Convulsions have been known to occur.

TRAUMATIC CYANOSIS

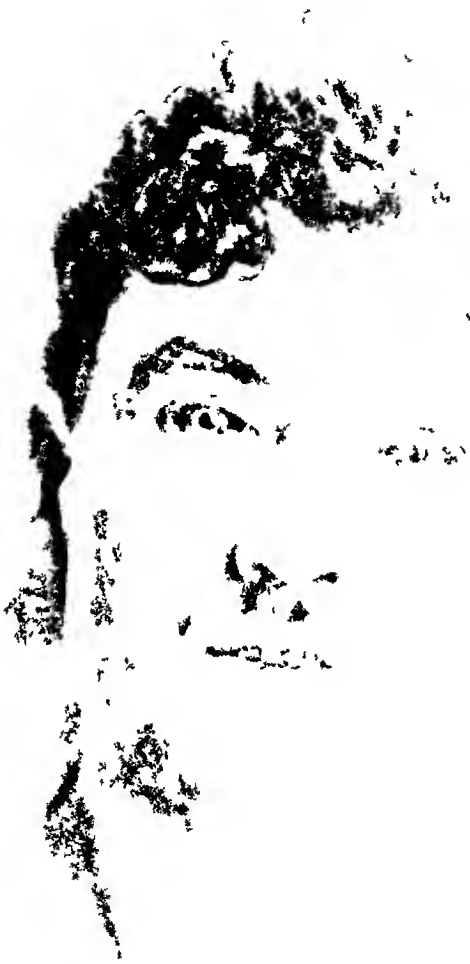


FIG 1 —Traumatic cyanosis.

The interesting point in relation to this syndrome is its pathological physiology. First, what happens? The compression of the thorax causes cessation of respiration, increased intrathoracic pressure, and thus compression of the superior vena cava, the latter causes the venous blood therein to attempt to get backward.

Second, why the peculiar distribution of the cyanosis, as described? Perthes' explanation is that there is a lack of competent valves in the veins in this area. "There are no valves in the innominate and internal jugular veins except a pair where jugulars enter the innominate. There are two pairs in the external jugular—one at its junction with the subclavian, and the other just above the clavicle." All of these are incompetent.

Third, why the discoloration or cyanosis? There is a great difference of opinion on this topic. Hueter says that, (1) it is due to the extreme distention and rupture of the vessels of the skin from the sudden upward pressure, or, (2) that, due to the trauma, there is sympathetic nerve paralysis leading to vasomotor paralysis, which leads to the distention of the vessels with blood. Perthes believed that the capillaries are actually ruptured. Buriell and Crandon accept the paralysis theory. Beach and Cobb feel that there is not an extravasation of blood outside the vessels, but that the upward pressure has caused the dilation of the vessels in the region of the incompetent or absent valves. These investigators removed sections of skin for microscopic study and found normal skin except for dilated vessels. There was no sign of extravasated blood or of ruptured vessels. They also pointed out that the discoloration blanches a little on pressure, and does not go through the various stages of coloration as seen in extravasated blood.

Winslow found, on microscopic section from his case, that the condition was as described by Beach and Cobb. Bolt's findings agreed with the above three observers. Robertson and Braun, however, found blood in tissues of skin outside the blood-vessels.

The case here reported showed no change of the cyanosis to the various stages of discoloration as seen in extravasated blood. A specimen was unable to be obtained.

These cases frequently have severe ocular or visual injuries. There are reported cases of optic atrophy, retinal hemorrhage and degeneration following traumatic asphyxia.

CONCLUSION

1. A case of traumatic asphyxia is reported with recovery.
2. The prognosis, from the literature, is good if the trauma is not fatal shortly after its occurrence.
3. The cyanosis of the head, face and neck, with subconjunctival hemorrhages is characteristic of the condition.
4. The distribution of the cyanosis is probably due to incompetent or absent valves of the region, allowing back pressure produced by compression of the superior vena cava to cause a distention of, or a paralysis and a stasis in, the small vessels.

TRAUMATIC CYANOSIS

BIBLIOGRAPHY

- Anderwert, Emil Ueber staunungsblutungen nach Rumpfkompensation Inaugural Dissertation Zurich, 1906
- Bager, B Traumatic Asphyxia Hygiea, vol lxxvi, pp 229-242, April 15, 1924
- Ab, J A M A, vol lxxviii, p 78, July 5, 1924
- Bandit Sur un cas d'infiltration ecchymotique diffuse de la face a la suite d'une compression brusque du tronc Toulouse Med, 1910, vol xii, pp 59-62
- Beach, H H A, and Cobb, F Traumatic Asphyxia ANNALS OF SURGERY, 1904, vol xxxv, pp 481-494
- Beal, Raymond Des hemorrhagies ictiniennes dans la compression du thorax These de doct, Paris, 1906
- Beal, Raymond Hemorrhagie ictinienne, oedeme ictinien et atrophie optique par compression du thorax et du cou Ann d'occul, 1909, vol cxlii, pp 89-98
- Beatson, G T Case of so-called Traumatic Asphyxia Glasgow M J, 1907, vol lxxviii, pp 426-428
- Berrisford Paul D The Ophthalmological Findings in Traumatic Asphyxia, with Report of a Case Arch Ophthal, 1921, vol i, pp 411-421
- Birge R H Report of a Case of Traumatic Asphyxia Cleveland M J, 1905, vol iv, pp 389-393
- Bolt, R A Traumatic Asphyxia, Report of a Case Cleveland M J, 1908, vol vii, pp 647-659
- Borchardt A Case of Traumatic Asphyxia Berl klin Wchnsch, 1904, vol xli, p 683
- Braun, H Extravasation sanguine etendue a la tete, au cou et au bras gauche, consecutive a une compression de l'abdomen Semaine Med, 1899, p 383, Deutsche Ztschr f chir, 1899, vol li, p 599
- Braun, H Staunungsblutung nach Rumpfkompensation Deutsche Med Wchnsch, 1901, vol xxxiii, p 15
- Braun, H Weitere Beitrage zur Kenntniss der Staunungsblutungen nach Rumpfkompensation Deutsche Ztschr f Chn, 1901, vol lxxiv, pp 411-417
- Burrell, H L, and Crandon L R G Traumatic Apnea or Asphyxia Boston M and S J, 1902, vol cxlvi pp 13-15
- Clinton, F S Clinical Report of Two Cases of Traumatic Asphyxia J Oklahoma M Assn, 1919, vol xii, p 330
- Despard, D L Traumatic Asphyxia ANNALS OF SURGERY, 1909, vol xlix, pp 751-761
- Ettlinger, W Ein Fall plotzlicher Kompression des Brustkorbes und Abdomens mit sekundaeren Haeorrhagien, Oedem and Zyanose des Gesichtes und Halses Wien klin Wchnsch, 1907, vol xx, pp 665-667
- Garson, G H R Traumatic Asphyxia Brit M J, 1910, vol i, p 990
- Green, T M Traumatic Asphyxia S, G and O, vol xxxv, No 2, pp 129-131, August, 1922
- Gueckel, E Ein Fall von Druckstauung Zentralbl f Chir, 1901, vol xxviii, p 312
- Gueckel, E Ein Fall von Druckstauung Zentralbl f Chir, 1906, vol xxxiii, p 936
- Henry, C K P Traumatic Asphyxia Montreal M J, 1907, vol xxxvi, pp 492-494
- Herzenberg, R L Staunungsblutung nach schwerer Rumpfkompensation Russ Arch f Chir, 1907, ab Zentralbl f Chir, 1908, vol xxxv, p 1410
- Heuer, G J Traumatic Asphyxia, with Especial Reference to its Ocular and Visual Disturbances Surg, Gyn and Obs, vol xxxvi, pp 686-696, May, 1923
- Hueter, C Deutsche Ztschr f Chir, 1874, vol iv, pp 382-386
- Joynt, R L Notes on a Case of Pressure Stasis Lancet, Lond, 1905, vol i, pp 856-857
- Koch, Aage, and Roenne, Henning Staublutungen bei Compression der Brest und des Unterleibes Arch f klin Chir, 1910, vol xci, pp 371-380
- Kossobudzki Zur Kosmstic der Traumen des Brustkorbes Medycyna, 1902, m 30 and 31

- Kronlein Presentation of a Case of Traumatic Asphyxia Cor Bl f Schweiz Aerzte, 1905, vol xxv, p 458
- Kunz, H Hemorrhages from Compression of Trunk Milt a d Grezgeb d Med u Chir, vol xxxvii, pp 235-242, 1923 Ab J A M A, vol lxxvii, p 1742, May 24, 1924
- Lang Optic Atrophy Secondary to Hemorrhage into Optic Sheath Ophthal Rev, 1909, vol xxviii, p 91
- Lange, Elich Stauungsblutungen infolge traumatischer Rumpfkompresion Deutsche Ztschr f Chir, 1913, vol cxx, pp 76-136
- Lawrence, C S Case of Traumatic Asphyxia Virginia M Monthly, vol xlix, pp 664-665, February, 1923
- Le Dentu Bull et Mem Soc de Chir de Par, 1906, vol xxxii, p 278
- Lejars, F L'infiltration ecchymotique diffuse de la face, a la suite des compressions du tronc Semaine Med, 1905, No 16, pp 181-183
- Linington, W W Traumatic Asphyxia South M J, Lond, 1915, vol ii, pp 911-912
- Mauclair and Burnier, R Le masque ecchymotique de la face par compression thoracique Arch Gen de Chir, 1919, vol iv, pp 902-923
- McKenna, W B Traumatic Asphyxia Atlantic M J, vol xxvii, p 745, August, 1924
- Milner, Richard Die sogenannten stauungsblutungen infolge Ueberdrucks ein Rumpf und dessen Verschiedene Ursachen Deutsche Ztschr f Chir, 1905, vol lxxvi, pp 85-147, *ibid*, pp 585-589
- Mitchell, L J C A Case of Traumatic Asphyxia Brit J Ophth, vol x, pp 417-418, August, 1926
- Moeser, Paul Ueber Netzhautblutungen nach Thoraxcompression Dissertation, Leipzig, 1906
- Moncrieff, A Traumatic Asphyxia Lancet, vol i, p 1307, June 30, 1923
- Morestin Masque ecchymotique dans les compression thoraco-abdominales Semaine Med, 1906, vol xvi, p 8
- Neck, K Ueber "Stauungsblutungen nach Rumpfkompresion" Deutsch Ztschr f Chir, 1900, vol lvii, pp 163-168
- Niemann, A Ueber Druckstauung (Perthes) oder Stauungsblutungen nach Rumpfkompresion (Braun) Inaugural Dissertation, Strassburg, 1903 (Autopsy by Von Recklinghausen, Muenchen, Med Wchnschr, 1900, vol lvii, p 984)
- Ollivier (D'Angers) Relation Medicale des evenements survenue au Champ-de-Mars le 14 Jun, 1837 Ann d'hyg, 1837, vol xviii, p 485
- Parker, F G Optic Atrophy from traumatic asphyxia, with report of a case Arch of Ophthal, 1911, vol xl, pp 159-162 (Case of E Eliot, ANNALS OF SURGERY, 1910, vol lii, p 408)
- Perthes, G Des extravasations sanguins etendues a la tete, consecutives a la compression du thorax Semame Med, 1899, p 334 Deutsche Ztschr f Chir, 1898-1899, vol i, pp 436-443
- Perthes, G Ueber "Druckstauung" Deutsche Ztschr f Chir, 1900, vol iv, pp 384-392
- Pichler, A Ein neuer Fall von multiplen Blutungen der Kopfhaut und des Auges nach Compression des Brustkorbs Ztschr f Augenhilk, 1901, vol vi, pp 134-139
- Pierce, F E Traumatic Asphyxia, with Report of Two Cases Quart Bull Northwest Univ M Sch, Chicago, 1910, vol xi, pp 39-44
- Robertson, W S A Case of Traumatic Asphyxia Brit M J, 1905 vol ii, pp 1339-1340
- Robertson, L B Traumatic Asphyxia, with Report of Six Cases Canadian M Assn J, 1914, vol iv, pp 501-507
- Robinson, H B A Case of Traumatic Asphyxia Brit J Surg, 1914-1915, vol ii, pp 172-173

TRAUMATIC CYANOSIS

- Roset, J Un caso de equimosis difuso de la cara y cuello á consecuencia de la compresion del tronco Med de los Niños, Barcel, 1906, vol vii, p 300
- Ruppanner, E Ueber Stauungsblutungen nach Kompression des Rumpfes Cor Bl f Schweiz Aertzte, 1909, vol xxxv, pp 45-56
- Ryerson, E S A Case of Traumatic Asphyxia Canadian Pract and Rev, 1907, vol xxxii, pp 195-201
- Scheer, M Netzhautblutungen infolge von Kompression des Thorax Arch f Ophthal, 1904, vol li, pp 311-314
- Schultze, Eugen Zwei, Faele von Stauungsblutungen nach Rumpfkompresion Zentralbl f Chir, 1908, vol xxxvi p 1030 Arch f klin Chir, 1909, vol xci, pp 1100-1102
- Sherrill, J G Traumatic Asphyxia South M J Birmingham, 1917, vol x, pp 568-570 J Am Med Assn, 1917, vol lxxviii, p 1237
- Shmonck, F Traumatic Asphyxia Wisconsin M J, 1904-1905, vol iii, pp 78-79
- Sick, P Ueber Stauungsblutungen durch Rumpfkompresion (Traumatische Stauungsblutungen) Deutsche Ztschr f Chir, 1905, vol lxxvii, pp 595-603
- Stokes, H Traumatic Asphyxia and Injury to Brachial Plexus Tr Roy Acad Med, Ireland, 1910, vol xxxiii, p 203
- Tardieu, Ambroise La Mort par suffocation Ann d'hyg, 1885, No 2, vol iv, pp 371-441
- Tardieu, Ambroise Etude medico-legale, sur la pendaison, la strangulation et la suffocation 1870
- Traver, A H Traumatic Asphyxia J A M A, vol lxxv, pp 843-844, March 24, 1923
- Villemin Le masque ecchymotique par compression thoraco-abdominale Bull et Mém Soc de Chir de Par, 1906, vol xxxii, pp 273-278
- Voelcker, F Vorlaeufiger Bericht ueber die Verletzungen bei der Heidelberger Eisenbohn-Katastrophe Deutsche Med Wchnschr, 1900, vol xxvi, pp 807-810
- Von Morian Ueber einen Fall von Druckstauung Muenchen Med Wchnschr, 1901, vol xlviii, p 61
- Wagenmann, A Multiple Blutungen der Aeusseren Haut und Bindehaut combinirt mit einer Netzhautblutung nach schwerer Verletzung compression des Koerpers durch einen Fahrstuhl Arch f Ophthal, 1900, vol li, pp 550-562
- Wegner Bertrag zur sogenannten Druckstauung des Kopfes nach Brustguetschung Charite-Ann, 1903, vol xxvii, pp 296-299
- Wienecke, H Ueber Stauungsblutungen nach Rumpfkompresion Deutsche Ztschr f Chir, 1904, vol lxxv, p 37-50
- Willers, Gerhard Ueber die Dilatation der Blutsgefasse des Kopfes bei schweren Verletzungen des Unterleibes Dissertation, Griefswald, 1873
- Wmslow, Randolph A Case of So-called Traumatic Asphyxia Med News, 1905, vol lxxxvi, pp 207-208
- Wiener, G Infiltration Diffuse de la face par compression thoracique J Méd de Brux, 1907, vol vii, pp 243-246

APPLICATION OF THE PRINCIPLE OF THE QUARANTINE IN ABDOMINAL SURGERY*

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AN ADDRESS on an occasion of this kind should deal with general principles. While the principle of the quarantine has been much used in abdominal surgery, it has not been sufficiently defined and isolated as a principle.

Rather has it been classed under the general heading of "Drainage."

Long ago surgeons discarded unprotected gauze as a drainage agent in the abdomen. This is correct when applied to pure drainage of an enclosed cavity, such as the entire abdominal cavity in a general peritonitis, or an enclosed abscess cavity wherever found. Therefore, in general peritonitis a tube or other non-porous substance is preferred. Likewise, for an enclosed abscess cavity

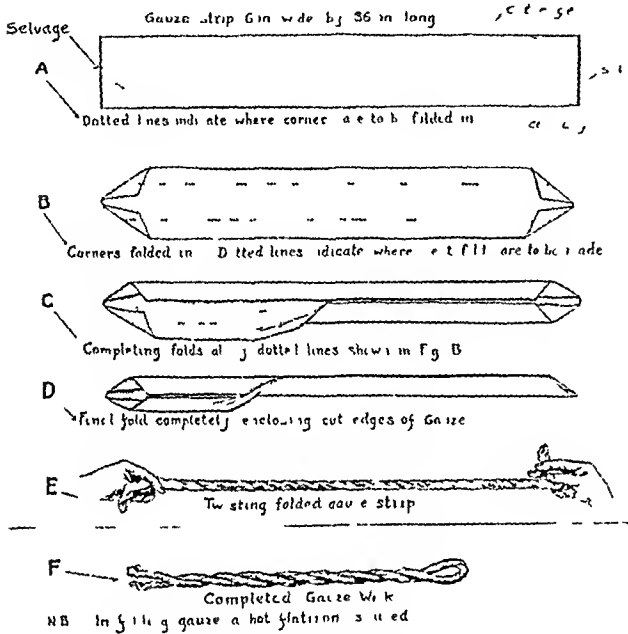


FIG. 1.—The preparation of a double gauze wick.

Yet, under certain circumstances, when properly used in sufficient quantity, gauze is the most efficient of all drains, but it must never be allowed to come in contact with the free peritoneal surfaces in the general peritoneal cavity. In as much as drainage is a necessary part of a quarantine, it is necessary to discuss the principles of drainage when applied to the abdominal cavity.

Yates,† in his article on "Local Effects of Peritoneal Drainage," confirms the findings of previous investigators and makes the results more definite by his experiments. The experiments were with all forms of drainage, and by using many dogs he was able to definitely determine the time at which drainage ceased from the peritoneal cavity cases. By placing different forms of drains in the flanks of dogs and then in a certain number of hours filling the abdomen through an opening at the ensiform cartilage with carmine solution, he was able to determine definitely that all forms of drains were

* President's Address before the Western Surgical Association, October 14, 1926.

† Surgery, Gynecology and Obstetrics, December, 1905.

closed, so that absolutely no drainage from the peritoneal cavity would take place after six hours

By quotations from many investigators and experiments of his own, he concludes that drainage produces a flow of serum (lasting from a few hours to two days), which in quantity is out of all proportion to the fluid in the cavity to be drained, but in exact proportion to the amount of drainage material inserted, showing that the serum was poured out as a result of the irritation produced by the drains. From the work of other investigators and confirmed by his own experiments, he finds that gauze will not drain pus or blood

Acting on these facts, he condemns drainage of the peritoneum as a rule, on the grounds, (1) that it is impossible, (2) it is depleting, and (3) pus and blood are not drained

I believe that the scientific findings of Yates are correct and fundamental as far as they go. Capillary drainage is usually carried out by means of gauze which may or may not be encased in some smooth tube or tissue

My findings, both experimentally and clinically, confirm the conclusion of Yates and others that gauze will not efficiently drain pus or blood from a basin, nor from a closed abscess cavity. It will, however, drain either pus or blood from the free peritoneal cavity. Even coagulated blood or thick pus is liquified by the excessive flow of serum (noted by Yates as being useless and depleting) and is delivered to the surface in the form of a thin red non-coagulable fluid in the case of blood and a yellow fluid in the case of pus, which will frequently saturate the dressings and all the bedding in a short time, if the drainage material is sufficient in quantity and properly placed. Thus this seemingly useless flow of fluid serves the purpose of a solvent, and at the same time acts as an irrigator from within, out, in a manner impossible by artificial irrigation

By experiment, it is found that ten gauze wicks will drain exactly ten times as fast as one over the edge of a basin or out of a cavity. Therefore, drainage will be in exact proportion to the amount of gauze passing through the external wound. In draining water over the edge of a basin the flow ceases

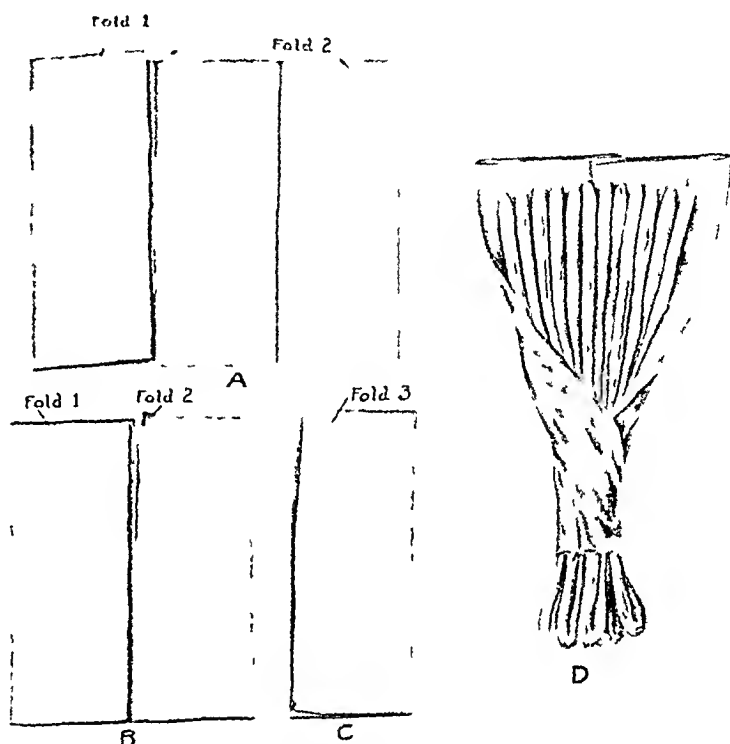


FIG. 2.—A, B and C shows steps in folding rubber tissue into a four-ply fold. It will be noted that only turned corners are exposed raw edges enfolded. D, architecture of quarantine when in place

when the water reaches the level of the outside end of the gauze, but starts again if a piece of gauze is pinned to the end of the drain and flows with a rapidity proportionate to the length of the external gauze below the level of



FIG. 3—Each wick end is carefully placed in the desired location with a long handled forceps making a row across the pelvis. After the wicks are in place two rubber sheets are made to cover all these wicks

the wound. Hence the large secretion of serum, and later of pus, surrounding the drain (mentioned by Clark), which was not delivered because of the insufficient drainage at the outlet and which later produced chronic fistula because the internal cavity was larger than its outlet.

Another feature which Clark did not emphasize in this connection is that in the use of the gauze pack in the abdominal cavity with an insufficient outlet for the flow of serum very extensive adhesions develop in the neighborhood. It may be said that the flow of serum is a stream of water bringing soldiers

and materials for defense to the seat of warfare to be used against a foreign body or enemy. This flow carries not only warriors, but materials for building a defensive wall

the fluid in the basin, thus acting on the principle of a siphon.

A gauze strip packed in a cavity like the "folds of a fan" and communicating with the surface by only a small end of the gauze strip, as described and condemned by Clark,[‡] creates a flow of serum in proportion to the amount of gauze in the abdominal cavity, but serum is delivered to the surface only in proportion to the size of the strip passing out through

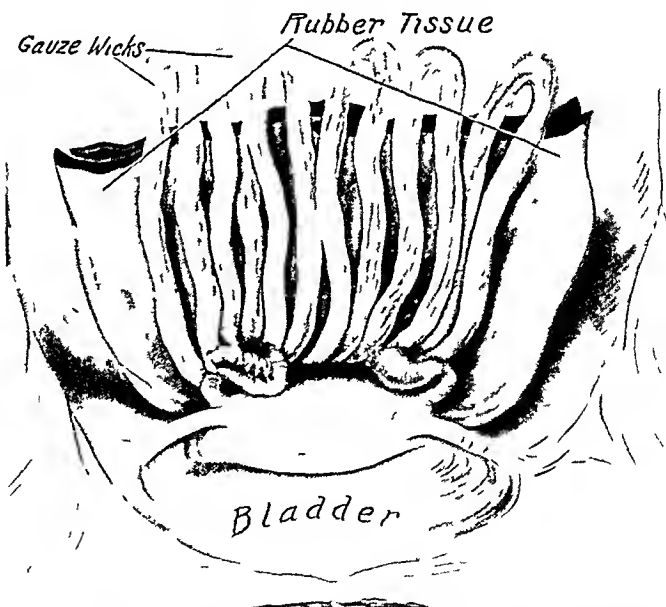


FIG. 4—Wicks and rubber tissue in place and turned back to show their relation to the open tubes and uterus the loop ends to be cut off after the wound is closed around the quarantine making twelve single wicks

[‡] Jour. of Obstet. and Dis. of Women and Children, April and May, 1897

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against the intruder. The materials are brought in proportion to the size and strength of the enemy or intruder. Nature is lavish in her defenses and therefore brings more materials than are necessary. As the water which has transported these materials to the field is absorbed, the fibrous elements gradually thicken, and if the quantity is too great, remains in the form of adhesions. Therefore if drainage is to be used in the peritoneal cavity, it must be of sufficient quantity and of proper quality to deliver the substance to be drained, as well as the excess serum, to the surface within a few hours. Therefore, if gauze is to

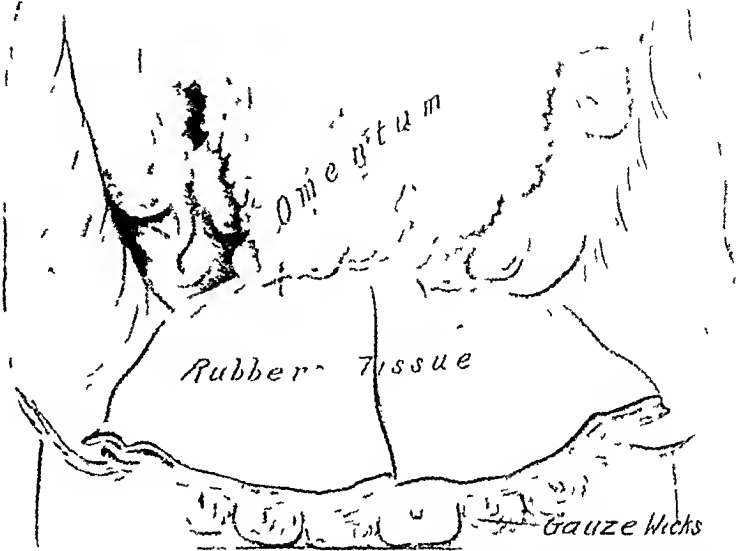


FIG 5 — Wicks in place showing how rubber tissue is interposed between gauze and free peritoneal cavity. Omentum where possible is interposed between intestines and rubber tissue.

be used as drainage, it must be in considerable quantity and the diameter of the drain must be as great where it emerges through the abdominal wall as at any point within the abdominal cavity. Furthermore, it must be sur-

rounded by a smooth, impervious substance, such as rubber tissue.

It is the purpose of this paper to isolate and apply the quarantine as a fundamental principle and I shall use it in the sense of a structure which has for its purpose the segregation or separation of an infected or diseased area from the remaining free peritoneal cavity. Such a structure to be workable must possess the following qualities:

1. The surface on the side of the general peri-

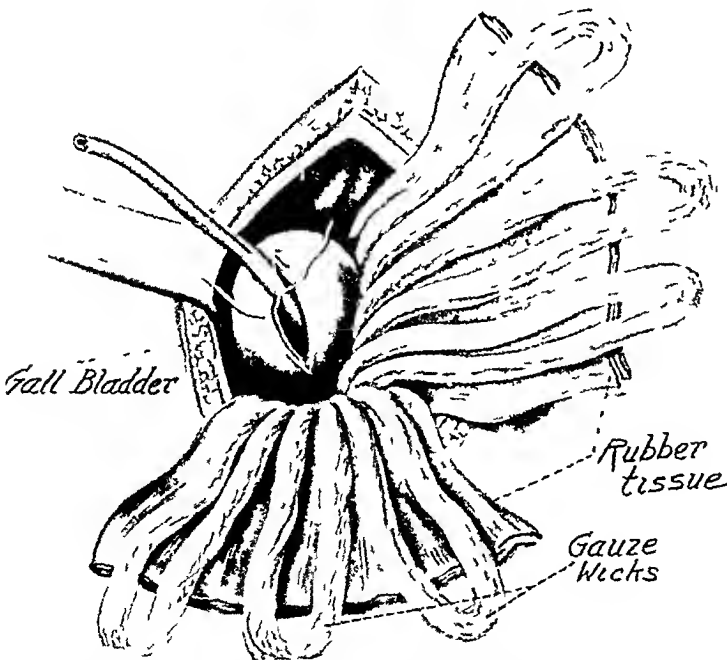


FIG 6 — Method of placing quarantine around a septic gall-bladder in an emergency where it is thought impractical to remove gall-bladder at the time. The rubber tube is non-essential.

toneal cavity must be smooth and inoffensive to the abdominal organ coming in contact with it.

2. It must remain accurately in place.

3 It must provide ample drainage of the infected or injured segment

4 It must be so constructed that it may be removed with the least possible trauma

The first quality is met by the use of an outside rubber tissue covering. The second by carefully arranging gauze wicks around the infected area. The gauze being porous and rough rapidly fastens itself to the tissues where it is placed and thus anchors the quarantine. The third (ample drainage of the segregated area) is provided by gauze leading to the surface. Fourth,

this gauze must be arranged in small wicks so that one may be pulled at a time without disturbing the defensive wall that Nature has placed around the quarantine.

A very important detail is the construction of a wick which is strong and which at the same time has no travelling edges. Such a wick is made from strips of gauze five or six inches in width, cut across a 36-inch bolt of gauze. We have used

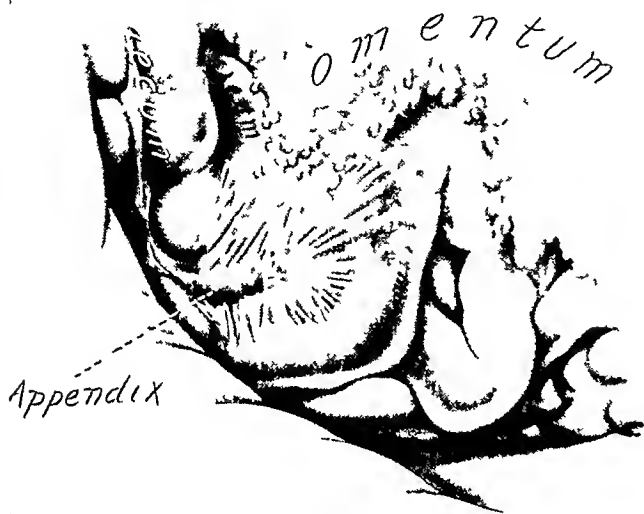


FIG. 7—Sub cæcal abscess surrounding a walled-off gangrenous appendix

Seabury and Johnson's Monitor gauze because of its strength. The steps in constructing this strip into a wick are shown in Fig. 1. It will be seen that the ends of the wicks are formed by the two selvage edges of the bolt of gauze. All the cut edges are securely turned in and ironed with a flat iron and the wicks twisted. The two ends are then brought together and again twisted. Six of these double wicks are placed in a package for sterilization. When unfolded for use, the two ends of the wick are untwisted from each other, but the pressing and twisting used in the preparation prevents the wick from unfolding and exposing the raw edges. When put into place, each wick is laid separately, bringing the middle or loop to the surface. After the loop is cut, the two ends left in the wound make two wicks to be removed. Twelve wicks of this kind are sufficient for holding a quarantine in place and draining the area. When these twelve wicks are massed together, brought to the surface and surrounded by four thicknesses of rubber tissue, a made-in cigarette diam approximately an inch in diameter is the result. The lower end is spread out in the shape of a fan, Fig. 2D, to surround the area to be quarantined.

The gutta percha covering is constructed as follows. Bauer and Black extra heavy tissue is used. It comes in bolts 5 yards long, 36 inches wide

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This bolt is cut transversely into strips one foot wide which would make fifteen strips in each bolt. Each strip is cut in two in the middle, leaving two pieces of tissue 12 x 18 inches. This strip is folded in its long diameter to four thicknesses, making a four-ply sheet of rubber tissue 12 inches long, 4½ inches wide, in which all cut edges are turned in, leaving none but folded edges exposed. By this method of folding, the greatest strength of the gutta percha fibre is longitudinal and therefore the sheet will not tear transversely. Aseptically the gutta percha is prepared and preserved as follows:

Gutta-percha, after it is cut in the desired length is put in 1-1000 bichloride and allowed to stand over night. It is then dried with sterile linen and folded making it ready for use. It is kept in a glass jar which has been autoclaved or boiled. This is done with sterile gown and gloves.

It is easier to apply a rubber tissue covering in two pieces of four and a half inches in width than one nine inches in width. Therefore, two



FIG 8—Quarantine in and around a sub-crecal abscess cavity
Ileum is held straight by quarantine

pieces are always used, three if necessary to effectively cover in the gauze. Speaking in terms of general principles, we have the following indications for the use of the quarantine in abdominal surgery:

- 1 Infected organs which tend to produce a peritonitis by contact or discharge but which organs are not to be removed
- 2 Intra-abdominal abscess so located that the wall is exposed to the intra-abdominal viscera and where the discharge must be conducted across the free peritoneal cavity after drainage is established
- 3 An open viscus which because of the presence of infection or for other reason it is impractical or undesirable to close at the time
- 4 Large denuded bleeding or infected areas where it is impossible to cover with peritoneum
- 5 Extensive recurrent adhesions which disturb the function of abdominal organs

Under the first heading, the most frequent application is for an infected uterus and tubes such as follow miscarriages, criminal abortion, gonorrhoeal infection, etc. All these infections tend to produce peritonitis, form abscesses,

or even general septicæmia and finally to leave a morbidity in the form of extensive adhesions which prevent the patient from enjoying health, although fatality is averted. There is nothing more like magic than the result after quarantining a septic uterus and tubes due to a pyogenic infection. Even tubes which are sealed and which contain acute abscesses may be split open and allowed to remain. The acute peritonitis and other septic symptoms will often disappear immediately after the quarantine has been placed. If the infection is due to the gonococcus, the same startling transformation takes

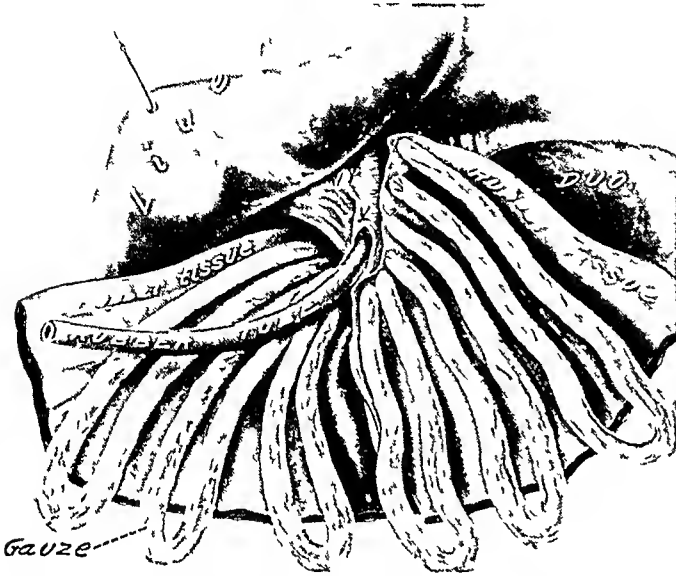


FIG. 9.—Method of application of quarantine surrounding an open duct which is septic or may possibly contain additional stones

place. If the tubes have not been sealed and a quarantine is thus placed, the fever immediately subsides and in the few cases in which I have used it before the tubes have become sealed, no recurrence of symptoms has taken place. No organs were sacrificed and no sequelæ or recurrence occurred such as follows so-called conservative treatment. In a much larger number of gonorrhœal cases in which the tubes were sealed and pus tubes had formed, the tubes were removed. If the infection is pyogenic, it is unnecessary to remove the tubes even though they are closed, for they may be split and laid open and brought within the scope of the quarantine. If the infection is known to be gonorrhœal and the tube has become sealed, it must be removed, for it is rare that a tube sealed by gonorrhœal infection opens and rarer still that it functions. By this means, the ovaries may almost invariably be saved even if the abscess involves the ovary. The abscess cavity may be laid open and drained and recovery will take place. In short, (a) the early quarantine of a gonorrhœal tube during the first attack of local peritonitis saves both the tubes and the ovaries and relieves the patient of much suffering and danger. (b) Even if the tubes have been sealed, the ovaries may be saved and the patient relieved of further morbidity and suffering.

Figures 3, 4 and 5 show the technic for the application of the quarantine pack for pelvic infections. The field is carefully exposed. The intestines are packed well up into the abdomen. The tip of each gauze wick in a long-handled forceps is placed at the exact point where it is desired to make a coffer-dam across the pelvic inlet. Usually the twelve wicks in one package are sufficient. These are laid perfectly straight, then the two sheets of four-

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ply rubber tissue are neatly fitted around the gauze until it is entirely covered on its posterior surface and carefully fitted around all the gauze above the fundus of the uterus, making of the quarantine a large cigarette drain as it comes out of the abdomen which has been expanded into a fan-shape inside the abdomen (See Fig 2D)

Another striking instance coming under the first heading is a septic or gangrenous gall-bladder which is particularly apt to occur in feeble old people. In such a case an incision is made through the right rectus muscle under local anæsthesia. The intestines are packed downward lightly with a moist gauze pack. A gloved hand gently slips in under the gall-bladder. A dozen wicks are arranged around it, and two sheets of rubber tissue on the outside of these (Fig 6). A stab wound is made in the gall-bladder, its contents removed and the incision closed. This is done without shock. Such a patient will often be tided over to good health when, if necessary, the gall-bladder may be removed very simply. For, after the use of the quarantine pack there are practically

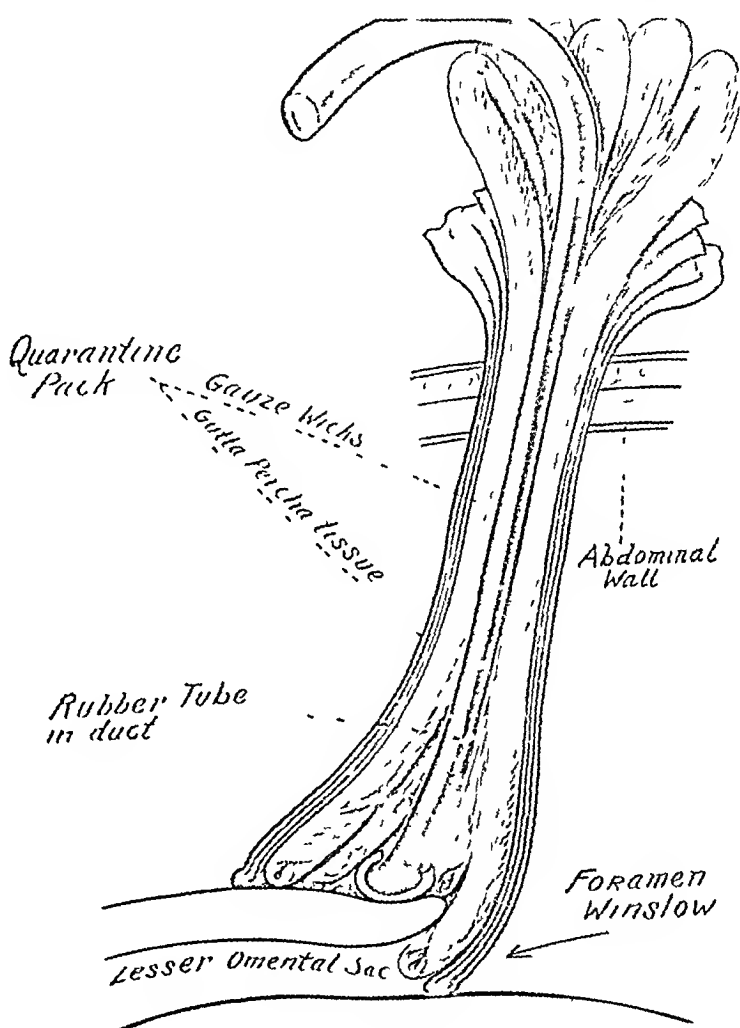


FIG 10 —Sectional view of combined quarantine and drainage tube in place

no firm adhesions such as occur following the introduction of a small drain for the reasons, (a) the drainage is sufficient to remove the excess serum with its fibrin-forming content, (b) rubber remains for two weeks interposed between two peritoneal surfaces, after which firm union does not take place.

The most outstanding instance of the second indication is that of the retro- or sub-cæcal abscess in cases of appendicitis. Figure 7 shows such a case. The coils of intestines have arranged themselves around the infected appendix to form an abscess wall which is located on the back wall of the abdomen underneath the end of the cæcum. A simple drain placed in such an abscess may save life, but the post-operative morbidity is great. Many cases of intestinal obstruction follow such drainage, for the loops of bowel imme-

diately arrange themselves around the drainage and attach themselves again to the abscess wall and very firm adhesions take place and post-operative obstruction often occurs—many times before the patient leaves the hospital

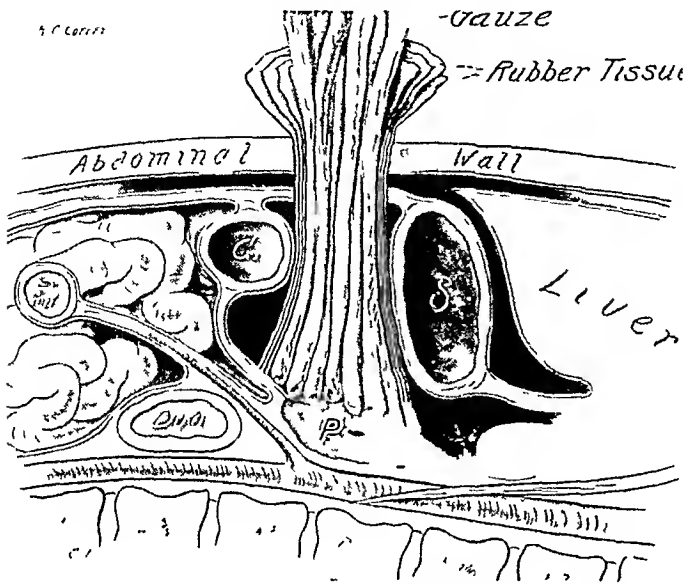


FIG 11—Application of quarantine where it is desired to drain an injured or infected pancreas

unnecessarily in the hospital as a direct result of the operation Others die in the hospital as a result of intestinal obstruction Still others, months or years later, require operation for intestinal obstruction due to the adhesions formed as a result of this defective

form of drainage For such a case a quarantine is ideal The abscess cavity is lined with the ends of a dozen wicks The gauze is then surrounded by the two sheets of four-ply gutta-percha tissue The ends of this gutta-percha passes along the parietal peritoneum somewhat beyond the abscess cavity The omentum is then

drawn down to the neighborhood and against the pack In such a case, not only is the drainage perfect, but post-operative adhesions and post-operative obstruction is practically unknown The same plan is applicable in perforating diverticulitis of the sigmoid, abscess of the liver, etc (Fig 8)

Some have sought to avert this by using three or four cigarette drains, say, for instance, one in the pelvis, one in the abscess cavity and one in the flank The post-operative morbidity is no less in this form of drainage than in single drain just mentioned, for the reason that the loops of bowel work in between the cigarette drains and attach themselves to the abscess wall Many such cases die

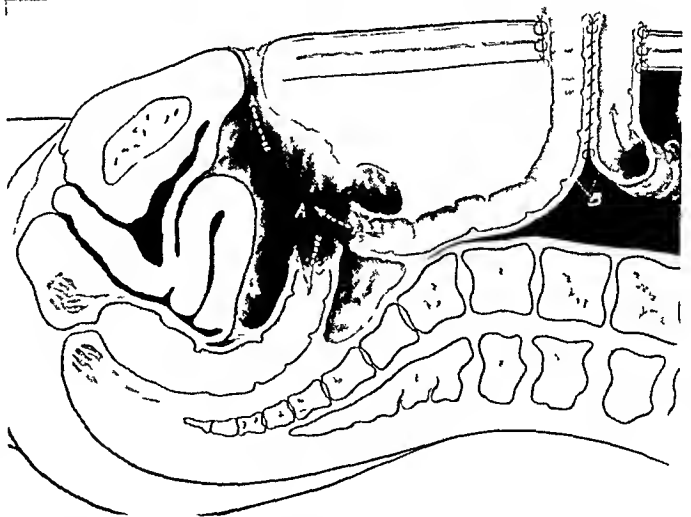


FIG 12—Two ends of severed intestine opening into a large abscess cavity, direction of fecal current before operation indicated by dotted arrow A B transverse colostomy instituted as first step toward final cure

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The most frequent case of Type III is found in common bile duct surgery in which the bile tracts are infected and in which pus or stones or both are in the common bile duct. Sometimes it is suspected there are stones well up in the hepatic ducts and it is desirable to leave the ducts wide open to permit of their escape.

At other times, the tissues around the duct are brittle, the cavity is deep and it is difficult to fasten tubes accurately in the common duct. In such a case, the quarantine pack is indicated. Figure 9 shows the application of a quarantine drain combined with a tube in such a case. The ends of the first wick are placed in the foramen of Winslow. The ends of remaining

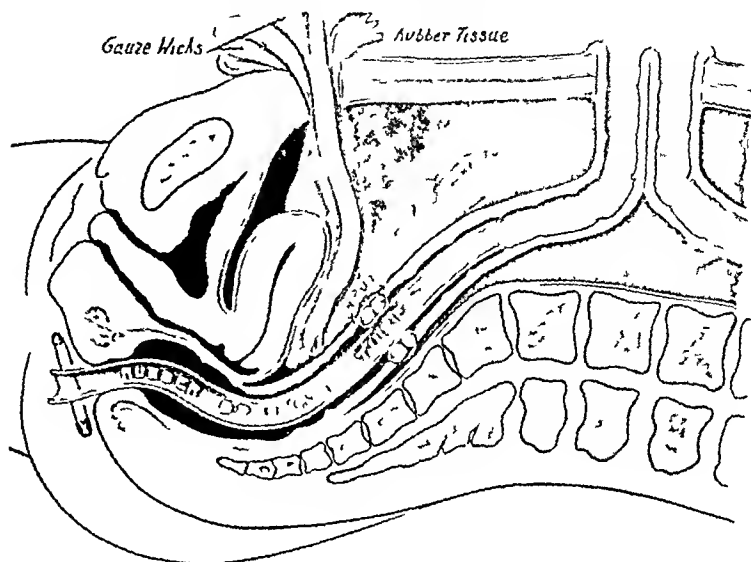


FIG. 13.—Intestinal anastomosis in the presence of an infected field protected by omentum quarantine pack temporary colostomy and a rubber drainage tube used in case illustrated in Fig. 12.

wicks are then carefully arranged upward along but just above the duodenum. It is important not to infringe upon the duodenum at any point. Finally the last wicks are placed beneath the liver above the duct. The tube and the gauze are then lifted upward and the two sheets of rubber tissue

carefully arranged around the wicks so that no abdominal viscus can come in contact. A tube tacked lightly in such a duct admits of the possibility of drainage around it and yet if there is no obstruction, it will deliver the bile through the tube, thus saving dressings. The danger to the patient is no greater, however, if the duct is left wide open and no tube is used at all, no

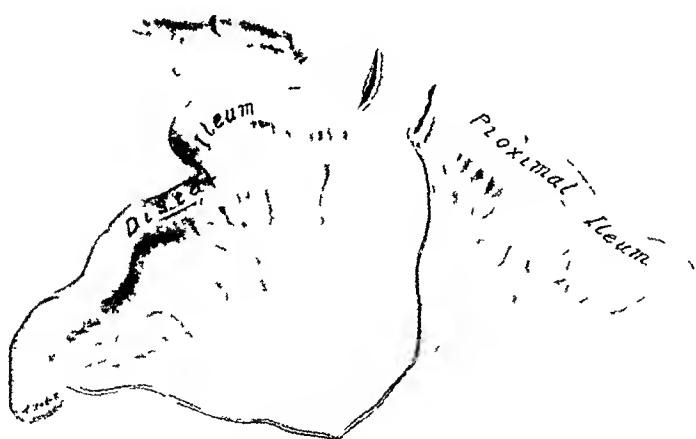


FIG. 14.—Preparing mesentery of the ileum to be used as a patch over hole in pelvic colon.

matter whether infection is present or not. Figure 10 shows the application of a quarantine of this kind.

Another type of case coming under Classification III is found in traumatic rupture of the pancreas, removal of a stone from the body of the pancreas,

the opening of an abscess of the pancreas, etc. It has been proven by Opie, the writer of this paper and others, that fat necrosis is always due to escape of pancreatic fluid into the retro-peritoneal fat plains, thence down the

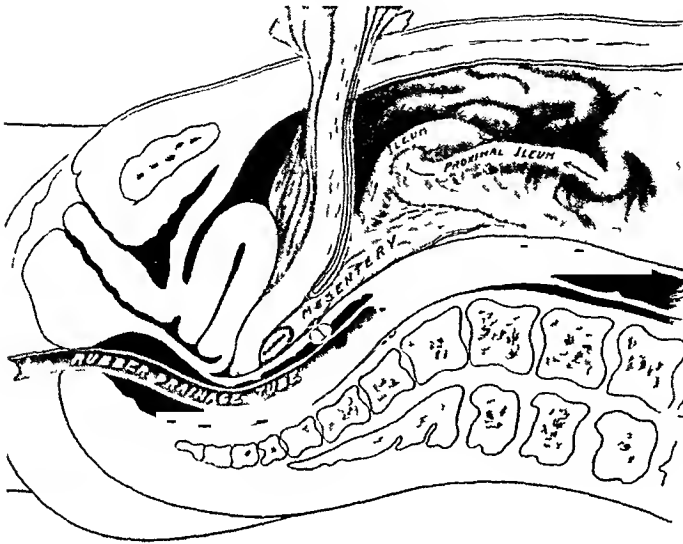


FIG 15 —Repair of hole in pelvic colon in presence of a pelvic abscess

the gastro-colic omentum. The rubber tissue in this case is made to entirely surround the gauze wicks.

Another indication for the quarantine is found in the case of necrotic bowel in which the patient is too fatigued to permit of a radical operation and in which the abdomen is filled with septic, foul-smelling fluid as is often encountered in strangulated hernia.

Still another indication is seen when the bowel is opened in the presence of an abscess such as is often encountered in pelvic operations. A striking instance is seen in the following case.

A patient had been operated upon in a distant city for an unusual pelvic tumor. In a few months the growth returned in the form of a cyst. In removing it, the sigmoid was torn entirely in two. It was sewed but broke down. The two ends separated. A large abscess formed in

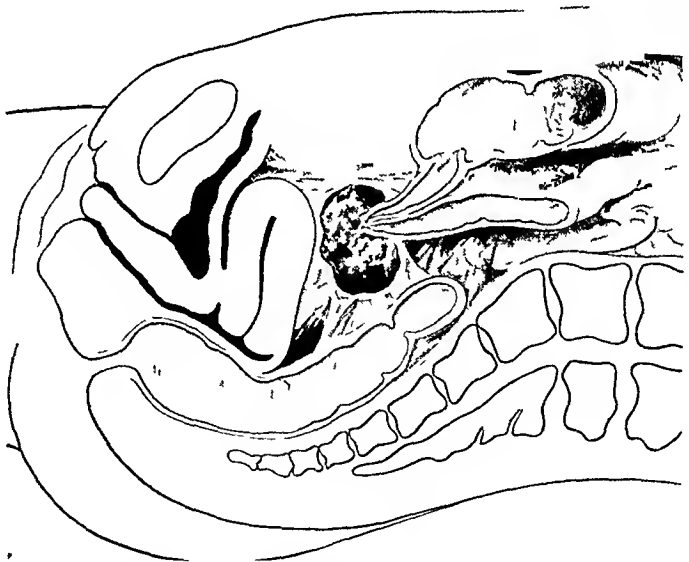


FIG 16 —A perforated knuckle of ileum emptying into and discharging from a large pelvic abscess

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the lower end of the abdomen and broke out through the lower end of the incision. Through this opening, pus, fecal matter and a gelatinous substance, characteristic of the tumor which was present, all discharged (Fig 12). Patient was in almost a moribund condition. Transverse colon was brought through an abdominal incision under local anæsthesia and a day later was opened to side track the fecal current. After a few days, a slight improvement occurred, but the improvement was not satisfactory. The patient was

still in a very serious condition. The abdomen was again opened. The abscess wall and the cyst wall were removed. The ends of the intestine were sewed together although not tightly. A rectal tube was placed in the rectum and passed beyond the incomplete anastomosis. The omentum was drawn down and tacked over the anastomosis, after which a quarantine of twenty-four wicks was placed across the pelvis to keep the intestines away from the infected area. The patient immediately began

to improve. The wicks were removed in six days. The gutta percha a week later. A perfect anastomosis resulted. After this drainage wound had closed, the colostomy opening was closed and the continuity of the intestine was restored.

In such an instance as where the colon is opened during the progress of an operation for a pelvic abscess, or in a case where the operation has been done previously, leaving a fecal fistula in the low pelvic colon, such an opening may be closed by bringing omentum down over it in the same manner. (See Fig 13.)

If, in such a case, it is found that the omentum has been destroyed at the previous operation, or at least cannot be brought down into the pelvis to cover the opening, the emergency may be met as was done in one case as follows. The ileum was severed about two feet above the ileo-cæcal valve. The distal end was turned in and closed by several layers of sutures. The proximal end was implanted into the side of the distal segment of ileum mid-

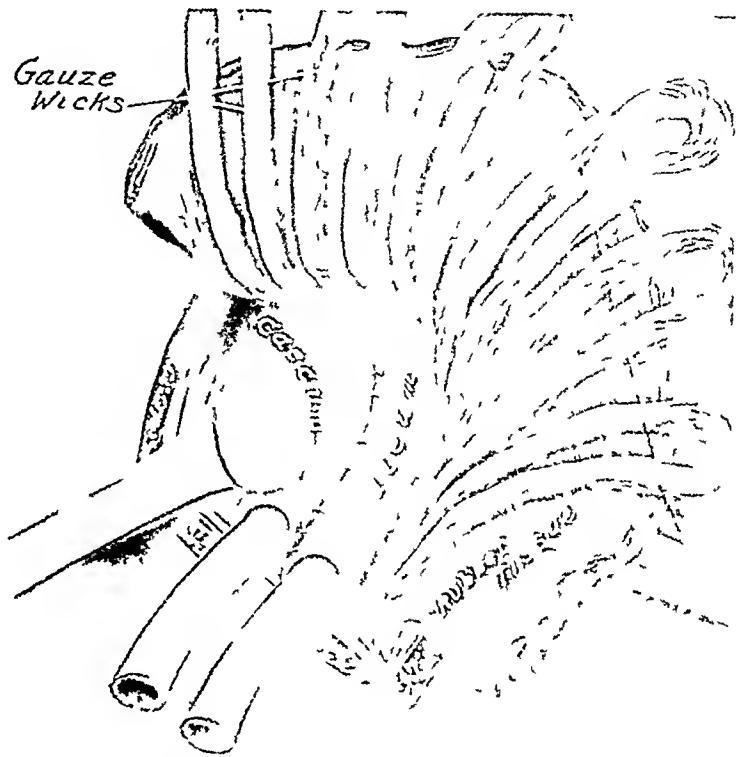


FIG 17.—After isolating the two ends of ileum from the abscess tubes are placed in the proximal and distal segments which are attached to the parietal peritoneum and surrounded by a quarantine. Used in case illustrated in Fig 16 and is applicable in case of strangulated hernia.

way between its end and the ileo-cæcal valve by an end-to-side anastomosis (Fig 14) The mesentery was cut and the edge of the proximal segment was sewed to the upper surface of the distal mesentery, the stump with its mesentery was brought down into the pelvis and the mesentery was tacked down over the opening in the colon The quarantine pack was then placed across the pelvis, tube was placed in the rectum, and the closure of the fistula was completed just as if we had used the omentum (Fig 15) Figure 16 shows a case for the application of the principle where an intestine has become

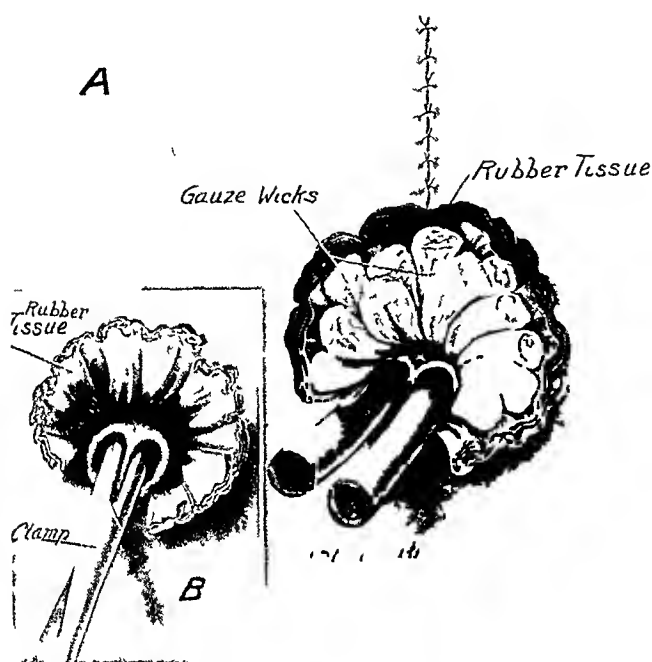


FIG 18 —Quarantine surrounding septic area and the two open intestinal ends. Insert shows cutting the lumina of the two intestines together by a clamp using Mikulicz plan. At a later date when the rubber tissue is removed an ordinary fecal fistula remains

gangrenous and has sloughed and in which the infection is too widespread and the patient is too sick to withstand an intestinal anastomosis. The sloughing of the bowel in this instance had taken place gradually and an abscess had formed. A part of the intestinal contents after going into the abscess worked down through the distal segment. The patient was entirely unable to stand a major operation. The abscess wall was enucleated. The severed ends of the ileum were liberated. A tube was passed into the severed proximal end of the ileum while another was passed into the distal ileum and cæcum, forming a double-barrel shotgun effect. The intestines were then tacked to the parietal peritoneum on one side of the wound. A quarantine wall was placed entirely around the infected area and around these intestinal loops (Fig 17). In a few days, tubes came away and wicks were removed. A clamp was used to cut the two intestines together by the Mikulicz plan. Later the rubber tissue was removed, the wound gradually healed, leaving a fecal fistula which was later closed by the extraperitoneal method first described in the *ANNALS OF SURGERY*, June, 1908. This application may appropriately be made for advanced strangulated hernia.

A fourth type of case in which the quarantine is applicable is seen in extensive pelvic disease in which large areas of peritoneum have been removed. The patient is in a depleted condition—oozing is taking place in the oedematous tissues which cannot be stopped with forceps, and it is necessary to control with pack. Or it may be that in such a case there is added

PRINCIPLE OF THE QUARANTINE IN ABDOMINAL SURGERY

to the bleeding, infection. The quarantine pack is ideal in such a case for it not only stops the bleeding but gives ample drainage and the smooth rubber tissue bars coils of intestine from the traumatized field where they might be ensnared in a mass of adhesions.

I think one of the most satisfactory uses for the quarantine pack is found in the case of extensive adhesion producing inconvenience and making the patient an invalid. Such cases are sometimes found in certain individuals who have especially strong protective qualities, in whom the abdomen has been open many times. Adhesions have been cut and futile attempts have been made to repair the raw surfaces with the result that the adhesions were firmer than at the previous operation. In such a case if the adhesions are severed and a quarantine pack is thrown around the pelvic organs and the rubber tissue is made to cover practically all the pelvic cavity, the patient will be entirely relieved of adhesions in nearly all cases. As a matter of fact, I do not recall a single instance in which I have been called upon to reoperate for adhesions after the quarantine pack has been used in this manner. A similar indication is found in the neighborhood of the gall-bladder after the gall-bladder has been removed and the stomach has firmly adhered to the under surface of the liver and gall-bladder bed. Such a condition is likely to produce obstructive symptoms requiring extensive dissection to separate the stomach and pylorus from the under surface of the liver. While in such a case, the omentum drawn across the stomach is usually sufficient to prevent recurrence, it is well to remember that a quarantine inserted between the under surface of the liver and the stomach (with rubber tissue on the stomach side) produces equally good results.

The wicks of the quarantine are removed under primary light gas anaesthesia six or seven days after they have been placed. The rubber tissue is removed without anaesthesia fourteen days after operation. Nothing is reinserted.

ABDOMINAL INCISIONS TREATED BY THE "OPEN METHOD"

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THE importance of the simpler phases of surgical technic is apt to be obscured by the pardonable enthusiasm of the profession to discuss complex and profound topics. In this connection it might be noted that there is very little to be gained by perfecting the method of performing intestinal resections if we neglect to learn how to open and close the abdomen and treat the resulting wound effectively. Believing that there is still considerable light to be thrown upon this apparently simple subject, we offer the following resume of the healing of a series of 112 abdominal incisions made by the authors at the Fifth Avenue Hospital during the year 1926.

In order that we may make our topic as simple as possible, we confine our discussion to wounds made for the performance of abdominal operations during the course of which it was not found necessary to drain the peritoneal cavity. We believe it unwise to discuss drained and undrained wounds at the same time. The mechanical factors involved are too diverse to permit generalization.

To simplify the study of the behavior of these wounds, a special wound record was prepared, a facsimile of which will be found in Table I. This wound record contains certain features which will bear consideration. In common with all such records it carries the name of the patient and operator, together with the name of the operation and date. In the following points it differs from any similar records which we have seen.

There is a space for listing type of skin preparation. The chemical and mechanical means which are employed should be described in detail. There is probably no factor which has as strong an influence upon wound behavior as does relative skin sterility. It is obvious that if a certain type of skin preparation is producing relative asepsis, just what that skin preparation is and how it is applied must be stated.

Besides calling for the name of the incision used, there is a space for the name of the surgeon making the incision.

In recording the facts about wound closure, a line is allotted to each layer of abdominal wall on which is stated the kind of suture material used. The terms absorbable and non-absorbable we do not consider sufficient, believing that the size of material as well as the type of its preparation and the name of its maker should be given. It should also be noted that there is a space for entering the name of the individual placing each layer of sutures. This is important because in those clinics in which it is customary for the operator to turn over closure of the abdominal wall to an assistant, such a procedure is

ABDOMINAL INCISIONS TREATED BY THE "OPEN METHOD"

certainly a variable factor when considering the subsequent behavior of the wound

There is a space for listing non-absorbable retention sutures in which should be given the name of the material, its preparation, size and maker

Definite statement as to the type of antiseptic, if any, applied to the skin

TABLL I
WOUND RECORD

Patient's Name	Date of Operation
Name of Operation	Room number
Name of Operator	Assistants
Skin Preparation	
Type of Incision	Made by
Closure —peritoneum	Made by
posterior sheath of rectus	Made by
rectus muscle	Made by
anterior sheath of rectus	Made by
fat	Made by
skin	Made by
Tension sutures?	How placed?
Drainage	
Antiseptic applied to skin after closure?	
Type of dressing	
Were there any observed breaks in technique?	
Is there any reason why this wound should not heal by first intention?	
1st day	6th day
2d day	7th day
3d day	8th day
4th day	9th day
5th day	10th day
	11th day
	12th day
	13th day
	14th day
	15th day
Abbreviations P—pus S—serum B—blood G—gas √—Uncomplicated healing	
Sep—separation of skin	
Pathologist's Report	

Attending

after closure, should be made The same conditions which applied in regard to pre-operative skin sterilization hold good after the incision is closed

There is a place for the description of the drainage (in cases under discussion, the answer was always "none")

An expression of opinion by operator as to whether there were any apparent breaks in technic should be made If, during the course of operation, a glove has been torn or some other obvious possibility of infection occurred and the wound subsequently becomes infected, this information will be of great value

There should be expression of opinion on part of operator as to whether there will be any complications during the course of the wound healing This permits the notation of marked atrophy of abdominal musculature, constri-

tutional handicaps of the patient such as anæmia, cachexia, etc., and the presence or absence of marked jaundice. In the lower portion of the sheet are spaces for notation of condition of wound for fifteen days, which are filled in daily and initialed by the surgeon making rounds.

At the bottom is a space for any pathological reports in the case of infection. This feature we have practically discarded, believing that under the usual conditions of obtaining smears from infected wounds, the resultant growth cannot be proven to have come from within the anterior abdominal wall by culture alone, since the possibility of contamination with bacteria always present on the skin is not excluded. The following case might be taken as an instance. In a certain incision on the sixth day, a fluctuating mass was felt under the skin. There was no rise in temperature, pulse or respiration, no tenderness or other sign of local inflammatory process, and twenty-four hours later about a drachm of clear yellow serum was expressed from a small separation of the wound edges. The instant that the serum touched the skin it came in contact with bacteria in the surrounding pores and follicles and a culture taken at this time naturally showed the presence of bacteria. This, however, is not conclusive proof that the wound was infected. It is our belief that unless the material for culture is taken before there is any chance of it being contaminated by contact with the skin—and such circumstances are obviously impossible, unless taken by aspirating with a sterile syringe—positive growths from wound fluids do not prove wound contamination at operation. However, if a fluctuating mass forms in the incision, with signs of local inflammatory reaction and rise in pulse and temperature, and the fluid upon liberation, either artificially or spontaneously, proves to be pus when it first appears, there can be no question of the fact that the wound is infected and should be classified as such.

This wound record might be criticized as too complicated, but we do not see how any part of it could be deleted and permit a scientific study of wound behavior. There can be no argument about the fact that wounds containing chromic catgut frequently develop collections of serum which when expressed, contain short pieces of suture material which have become foreign bodies, while wounds containing only plain catgut are not subject to this complication as frequently. Hence it is obvious that in reviewing a series of wounds, the preparation of the catgut used should be definitely stated. If the profession is to learn anything about the value of different brands of catgut in the market, a statement of the brand used must be made.

Notwithstanding, it has been our experience that discussions of wound closure seldom, if ever, take cognizance of these features which are so important that a discussion of wound behavior must include their accurate description.

There are many ways of classifying wound healing. The following method is offered as simple but inclusive. We divide wounds into four classes—A, B, C and D.

Class A. During the healing of the wound there is no discharge of

blood, serum, gas or pus. It is to be understood that in the open treatment the oozing of a few drops of blood from the incision edges during the hour or so post-operative is not considered sufficient to take it out of Class A. Likewise if, when skin plasters are taken off there is a little bleeding when the scab is pulled off, it is not considered a complication.

Class B During the healing of the wound there have been no complications other than (1) discharge of a small amount of serum, in the absence of any signs of infective reaction in the wound, such discharge of serum lasting no longer than seventy-two hours and in no way hindering the recovery of the patient, (2) the release of a small amount of air from an artificial vent made at the wound end or, (3) the discharge of a small uninfected blood clot.

Class C During the healing of the wound there is at any time discharge of pus, the discharge, however, not lasting beyond the tenth day post-operative and in no way effecting the recovery of the patient.

Class D During the healing of the wound any complication arises which affects the recovery of patient, such as extensive infections lasting beyond the tenth day, or the spontaneous wound rupture.

These classifications are simple and we believe need no comment.

For purposes of brevity we do not discuss at this time the effect of the variable factors. We are submitting this series to support our contention that wounds treated by the "open" method yield exceptionally high healing average. The wounds under discussion have the following features in common: 1 In each instance, before operation, the skin was prepared by a dry shave, following the usual bath, and at the time of operation the area was scrubbed with ether and then an antiseptic applied—the antiseptic being either 2 per cent iodine in carbon tetrachloride or a mixture of 5 per cent methylene blue and 5 per cent gentian violet in 50 per cent alcohol. 2 Only catgut was used in the closures. 3 The peritoneal layer was closed with No. 1 plain catgut. 4 The fat layer was seldom, if ever, sutured. 5 The skin was closed with continuous No. 0 plain subcutaneous suture. 6 The skin edges were approximated by isinglass court plaster. 7 After operation the wounds were all treated in the following manner:

While the patient was still on the table the wound was thoroughly dried



FIG. 1.—Showing dressings with arrangement of bed clothing to allow desired exposure of wound.

by blowing over it hot air from a portable electric hair dryer. While on the stretcher returning to his room, a sterile towel was placed over the incision. When the patient was in his own bed, the wound was further dried by exposing it to the air. To accomplish this without endangering him from exposure the "double bed" is used, as shown in Fig. 1. When the wound is dry the night clothes are pulled down directly over the incision and no further dressing is applied to the skin. At no time were any gauze, towels, plaster (other than isinglass court plaster), cotton or any other type of dressing applied.

The following chart (Table II) explains itself.

TABLE II
WOUND SHEET SUMMARY FOR YEAR 1926

Total number of incisions		112
Total Pfannenstiel's		56
(Transverse, supra-pubic, pelvic approach) ¹		
Total McBurney's		23
(Muscle-splitting, appendiceal approach) ²		
Total Kocher's		23
(Transverse, upper abdominal approach) ³		
Total miscellaneous		10
Classification of wound healing		
		Percentage
Total A's	98	A's—87.5
Total B's	11	B's—9.8
Total C's	3	C's—2.7
Total D's	0	D's—0
Total A's in Pfannenstiel incisions	52—46.4	
in McBurney incisions	21—18.8	
in Kocher incisions	16—14.3	
in Miscellaneous incisions	9—8.0	
Total B's in Pfannenstiel incisions	5—4.4	
in McBurney incisions	1— .9	
in Kocher incisions	4—3.6	
in Miscellaneous incisions	1— .9	
Total C's in Pfannenstiel incisions		
in McBurney incisions		
in Kocher incisions	3—2.7	
in Miscellaneous incisions		
Total D's in all incisions	0	

REFERENCES

- ¹ In Samml. klin. Vortr. von Volkmann, n. f. No. 268.
² ANNALS OF SURGERY, Phila., 1894, vol. 18, pp. 38-43.
³ Text-book of Op. Surg., Kocher, London, 1903, pp. 226.

SURGICAL ANATOMY OF THE RECURRENT LARYNGEAL NERVE WITH ESPECIAL REFERENCE TO THYROID SURGERY

By CHARLES C HIGGINS, M D

OF CLEVELAND, OHIO

FROM THE CLEVELAND CLINIC

THE surgeon who deals with pathological conditions of the neck, particularly of the thyroid, encounters one structure of vital importance, *i e*, the recurrent laryngeal nerve

Only those who have seen injuries of the nerve so severe as to require tracheotomy, and have realized that the impairment of the voice might be permanent, can appreciate its vital importance

In reviewing the textbooks on anatomy and the pictures which illustrate the location of the recurrent laryngeal nerve, one is immediately impressed with the fact that opinions differ considerably as to the normal position of the nerve. Thus one author describes the nerve as lying directly in the tracheo-oesophageal groove, while others describe it as lying in a

lateral position. For this reason I carried out a series of dissections in an attempt to enlighten myself as to the real position of this nerve.

Let us consider first the *inferior recurrent laryngeal nerve*. Normally the tracks followed by the right and left nerves vary, so they will be discussed individually.

The *right nerve* arises in front of the subclavian artery, passes around the artery, and then passes obliquely upward to the side of the trachea (Figs 1-4). Usually it passes behind the inferior thyroid artery (Figs 5 and 6), however, occasionally it is seen in front of this vessel, and in cases in which a large adenoma of the thyroid is present at the lower pole the nerve may

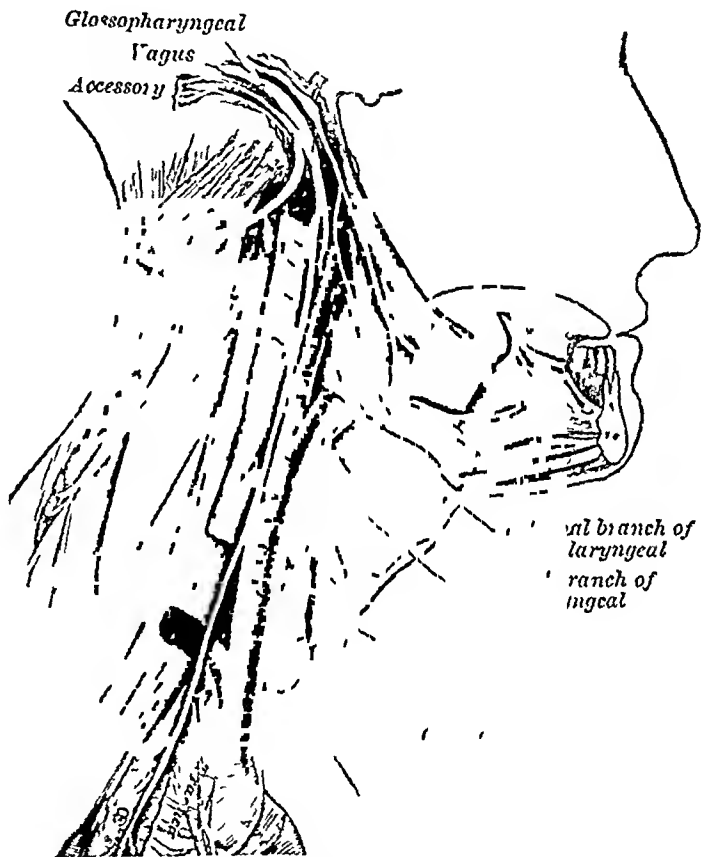


FIG 1.—The recurrent laryngeal nerve and superior laryngeal nerve (From Gray Anatomy of the Human Body 1918, 20th Ed p 909)

be displaced anteriorly for a considerable distance. It then ascends in the tracheo-oesophageal groove (Figs 7-9). About three-fourths of an inch before it enters the larynx it divides into two constant fibres. One of these divisions anastomoses with the internal laryngeal nerve which either pierces the inferior constrictor or passes beneath its inferior border, while the other branch passes into the larynx behind the articulation of the cricoid and the inferior corner of the thyroid cartilage (Fig 10). This fibre supplies the muscles of the larynx, with the exception of the cricothyroid muscle.

The nerve gives off several small but important branches

1 The cardiac branches, which end in the deep cardiac plexus. These branches arise as the nerve hooks around the subclavian artery.

2 The tracheal branches. As the nerve passes upward in the tracheo-oesophageal groove many small fibres are distributed to the trachea (Fig 11). These nerves are important and we shall discuss them in detail later.

3 The muscular branches. As the nerve passes upward these branches are seen to run to the anterior lateral wall of the oesophagus.

4 Fibres which extend to the inferior constrictor of the larynx.

5 Two more constantly present

FIG 2.—The distribution of the vagus nerve showing the right and left recurrent nerves—R. L. (From Cunningham *Text-Book of Anatomy* 1918 5th Ed. p. 787.)

fibres, arising about half an inch before the recurrent nerve enters the larynx. One of these branches passes to the oesophagus, near the junction of the pharynx with the oesophagus, and the other to the thyroid gland at its tracheal attachment.

The principal difference in the locations of the left and right nerves is in their origin. While, as stated above, the right nerve arises in front of the subclavian artery, the *left nerve* arises from the vagus as it passes over the arch of the aorta. It then winds around the arch just laterally to the ligamentum arteriosum, and passes upward along the tracheo-oesophageal groove (Figs 12 and 13). The distribution of branches is similar to that on the right side (Fig 13) and although the statement has been made that the branches are more abundant on the left side than on the right, this has not been noted in my dissections (Figs 14 and 15). Another difference which was noted was that in the tracheal region the right nerve lies farther to the front than does the left (Figs 16 and 17). The two nerves terminate in a similar way.

The *superior laryngeal nerve* arises from the ganglion nodosum. It

receives a branch from the sympathetic nerve system through the superior cervical ganglion, and passes downward beneath the external and internal carotid arteries toward the lower portion of the thyroid cartilage, where it divides into the two terminal branches, the external and the internal laryngeal nerves

The *external laryngeal nerve* passes downward beneath the sternothyroid muscle and supplies the inferior constrictor muscle of the pharynx and the cricothyroid muscle, in which it terminates. It also communicates with the superior cardiac nerve.

The *internal branch* passes through the hyothyroid membrane with the superior laryngeal artery and innervates the mucous membrane of the larynx. Branches also extend upward to the epiglottis and the base of the tongue. A communication between this internal branch and a terminal branch of the inferior recurrent nerve occurs after the latter has passed upward under the lamina of the thyroid cartilages.

Let us now consider the complications which result from injuries to the nerve. First of all, I



FIG 3—The recurrent laryngeal nerve. Anterior-posterior view.
 (1) Retracted left lobe of thyroid (2) Left recurrent laryngeal nerve
 (3) Retracted right lobe of thyroid (4) Right recurrent laryngeal nerve

want to call your attention to the fact that such an injury may occur even when the nerve has not been actually clamped with a hæmostat, as mere traction on the gland, especially at the superior pole, may tear loose the terminal branches of the inferior recurrent nerve.

As a routine procedure in the Cleveland Clinic pre-operative and post-operative examinations of the larynx are made by a member of the otolaryngological department. This enables us to check accurately the number of paralyses which are due to injury of the nerve and to correlate the operative result with the clinical findings.



FIG. 5.—The recurrent laryngeal nerve. Anterior-posterior view.
 (1) Left inferior thyroid artery (2) Left recurrent nerve passing under artery (3) Left recurrent nerve (4) Right inferior thyroid artery (5) Retracted lateral lobe of thyroid (6) Right recurrent nerve passing under artery



FIG. 4.—The recurrent laryngeal nerve. Anterior-posterior view.
 (1) Left recurrent laryngeal nerve (2) Right recurrent laryngeal nerve (3) Left inferior thyroid artery (4) Reflected right lobe of thyroid (5) Retracted lateral lobe of thyroid (6) Right recurrent nerve passing under artery

SURGICAL ANATOMY OF THE RECURRENT LARYNGEAL NERVE

Fig 6—The recurrent laryngeal nerve. Anterior-posterior view.
Note the nerve passing under the artery.



Fig 7—The recurrent laryngeal nerve. Anterior-posterior view.
Note the nerve passing up toward the tracheo-oesophageal groove
anterior to the inferior thyroid artery.





FIG 8—The recurrent laryngeal nerve. Lateral view (1) Terminal branch of the left nerve passing into the larynx (2) Division of the nerve passing into the oesophagus (3) The trachea (4) The oesophagus (5) The left nerve (6) The tracheo-oesophageal groove

not necessary to perform a tracheotomy before this second stage is reached, it may not be required at all

Injury of one nerve does not always give clinical symptoms. In fact, in seventy per cent of the cases in which a laryngeal examination reveals a unilateral abductor paralysis, the patients have been unaware of any difficulty. Compensation by the other cord has evidently taken place immediately. In cases in which a large adenomatous goitre is present, a pre-operative examination sometimes reveals a paralysis of one cord

To understand the course of the dyspnoea and hoarseness which characterize these injuries we must appreciate what happens to the cords when the nerve is injured. As the result of the injury the intrinsic muscles of the larynx are paralyzed, *i.e.*, the constrictors, the dilators and the tensors. Abductor paralysis is most frequently seen, as the abductor muscles receive the predominating fibres of the recurrent nerve. A laryngoscopic examination shows that, as the cord becomes flaccid and approaches the midline, the size of the lumen of the larynx is diminished. This causes the stridor and the dyspnoea which occur during the operation. Following this, the tonus of the cord is lost, the epiglottic chunk is enlarged, and the difficulty in breathing becomes less noticeable. This may be called the cadaveric position of the cord. If it is



FIG 9—The recurrent laryngeal nerve. Anterior-posterior view. Note the right nerve passing up the tracheo-oesophageal groove

SURGICAL ANATOMY OF THE RECURRENT LARYNGEAL NERVE

which has given rise to no symptoms. Usually a bilateral injury of the nerve, and occasionally also a unilateral paralysis, necessitates a tracheotomy, or the patient is unable to speak above a whisper. In very few cases, however, is a permanent tracheotomy necessary, usually the tube can be removed in one to three days and the wound allowed to heal.

A second post-operative complication which may develop is tracheitis. This can usually be anticipated during the operation, for if the trachea is denuded of its fascial covering, especially on its lateral aspect, a tracheitis

invariably develops. It is undoubtedly due to injury of the trachea and to the removal of the nerve filaments which pass from the recurrent laryngeal nerve

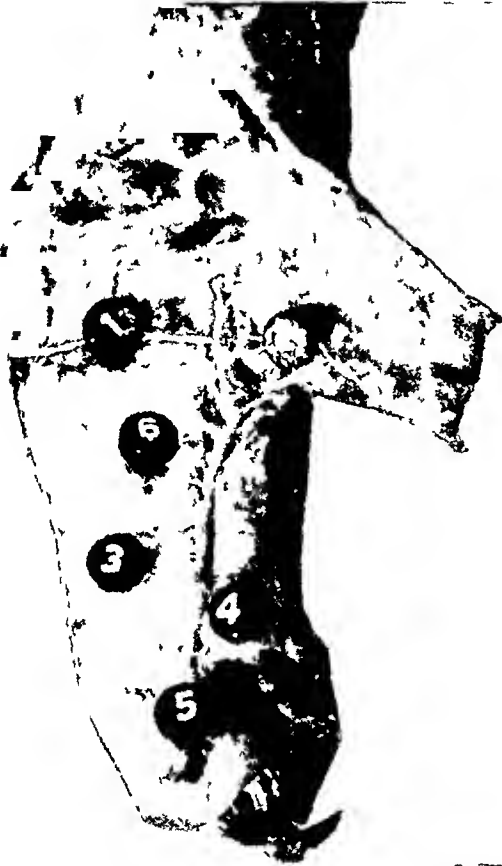


FIG. 10.—The recurrent laryngeal nerve. Lateral view. (1) Terminal branch of the left nerve passing into the larynx. (2) Division of the nerve passing into the oesophagus. (3) The trachea. (4) The oesophagus. (5) The left nerve. (6) The tracheo-oesophageal groove.

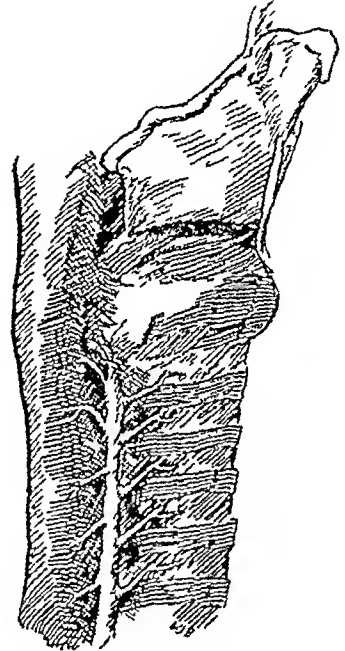


FIG. 11.—The recurrent laryngeal nerve (Diagram) Lateral view. Note the distribution of the small fibres to the trachea.

along the anterior lateral margin of the trachea. For this reason a small amount of tissue should be left as a covering for the trachea.

Occasionally difficulty in swallowing ensues after operation. This seems to be due to an impairment of the function of the epiglottis and I believe it can be explained by the fact that a communication exists between the superior laryngeal nerve and the inferior recurrent nerve, a terminal filament of the latter connecting with the internal laryngeal nerve which arises from the former, moreover branches from the internal branch of the superior laryngeal nerve pass to the epiglottis, so that if the recurrent nerve is injured the function of the epiglottis may be impaired.

Stridor, which may be only temporary or may necessitate a tracheotomy,

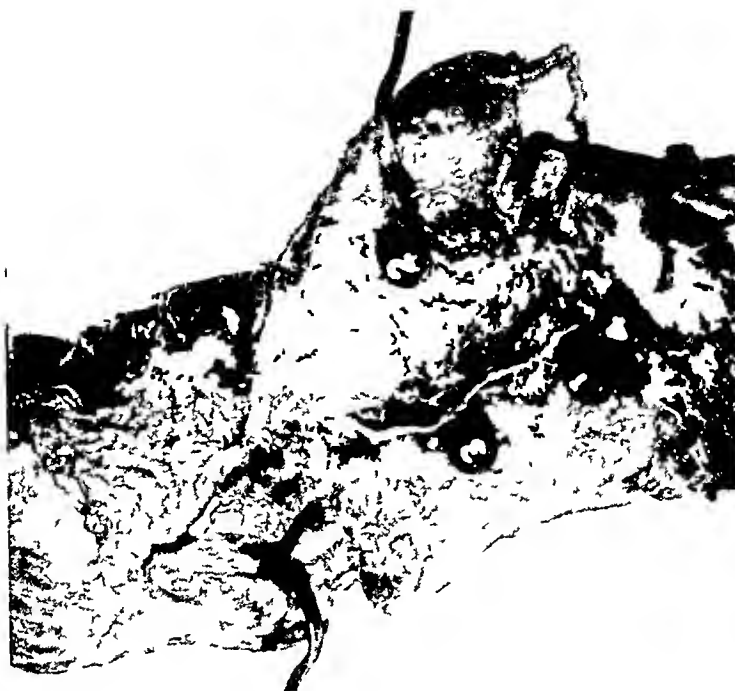


FIG. 13.—The recurrent laryngeal nerve. Lateral view. (1) The left nerve. (2) The left lobe of the thyroid. (3) The trachea. (4) The tracheo oesophageal groove.

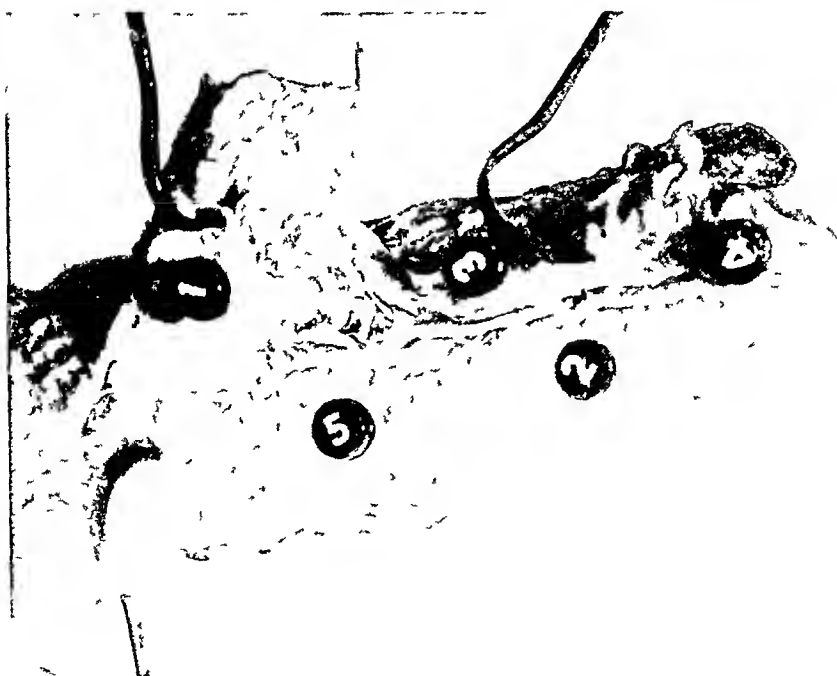


FIG. 12.—The recurrent laryngeal nerve. Lateral view. (1) Retracted left lobe of the thyroid. (2) The trachea. (3) The left nerve. (4) The tracheo oesophageal groove. (5) A branch of the nerve passing to the trachea.

SURGICAL ANATOMY OF THE RECURRENT LARYNGEAL NERVE

Fig 14—The recurrent laryngeal nerve. Anterior-posterior view
(1) Division of the nerve passing to the larynx (2) Division of the
nerve passing to the oesophagus (3) The inferior thyroid artery
(4) The left nerve (5) The oesophagus



Fig 15—The recurrent laryngeal nerve. Anterior-posterior view
(1) Retracted left lobe of thyroid (2) The left nerve with filament
passing to the trachea and the oesophagus (3) The left nerve
(4) The right nerve (5) Retracted right lobe of the thyroid



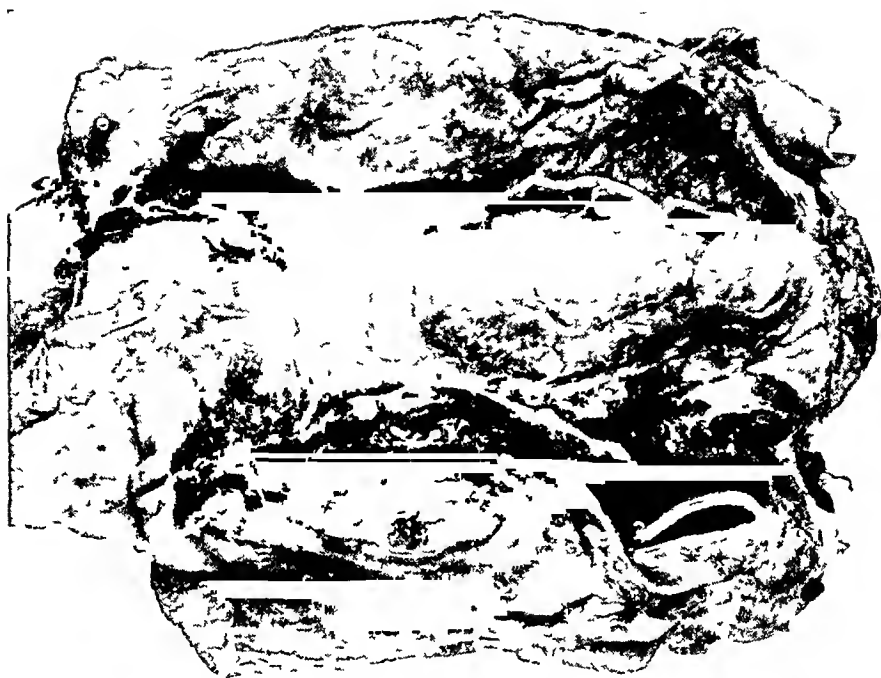


FIG 17—The recurrent laryngeal nerve. Anterior-posterior view. Note that the right nerve lies farther to the front than does the left which has been displaced upward.



FIG 16—The recurrent laryngeal nerve. Anterior-posterior view. (1) The left nerve. (2) The right nerve. (3) The left inferior thyroid artery. (4) The right inferior thyroid artery. (5) Retracted right lobe of the thyroid. (6) The carotid artery. Note that the right nerve lies farther to the front than does the left.

SURGICAL ANATOMY OF THE RECURRENT LARYNGEAL NERVE

may result from injury of the recurrent nerves. When this complication follows operation the patient is watched constantly and is never left alone. First of all the cords are examined to ascertain whether the paralysis is unilateral or bilateral. If the stridor continues, the pulse and respiration remain rapid, the accessory muscles of respiration are over-active, and the patient complains of the effort involved in breathing, a low transverse tracheotomy is performed *provided cyanosis is not present*. Occasionally compensation occurs in from four to six hours, in which case the tube can be removed.

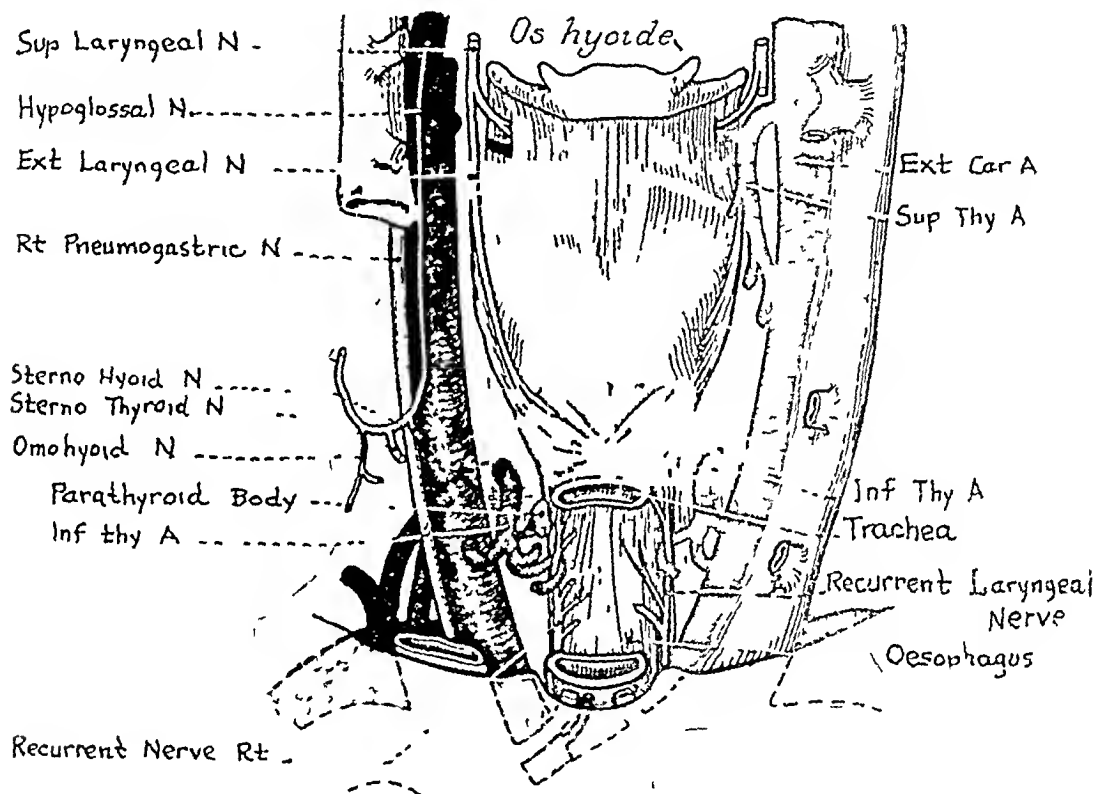


FIG 18—Relation of the right recurrent laryngeal to the hypoglossal nerve (From Pauchet and Dupret *L'Anatomie en Poche* 1926, Plate 133)

and the trachea reapproximated with one chromic catgut, the patient making an uneventful recovery.

If the damage is permanent, a permanent tracheotomy tube may be worn, or a plastic operation on the nerve may be attempted. In August, 1926, Frazier and Mosse¹ reported the results of anastomosis between the descending noni branch of the hypoglossal nerve and the recurrent laryngeal nerve (Fig 18). Improvement was noted in 60 per cent of their cases. Anastomosis with the phrenic nerve has also been accomplished.

Operations for the relief of injury of the laryngeal nerves have been described by Hoessly,² Schmerz,³ Guttman⁴ and others. In 1915 Payr⁵ described a plastic operation on the larynx for unilateral nerve injury and Schmieden⁶ has recently reported a very successful result following such an operation.

CONCLUSIONS

1 The prevention of injuries of the recurrent laryngeal nerve demands an accurate understanding of the anatomical relations of the nerve on the part of everyone who deals with surgery of the larynx or of the thyroid gland, (2) the fact that anomalies of the nerve may occur must constantly be kept in mind, (3) the patient who has suffered an injury to the recurrent nerve must always be kept under close observation in order to prevent an unfortunate sequel

REFERENCES

- ¹ Frazier, C H and Mosser, W B Treatment of Recurrent Laryngeal Nerve Paralysis by Nerve Anastomosis Surg, Gynec and Obst, 1926, vol XLIII, pp 134-139
- ² Hoessly, H Ueber Nervenimplantation bei Recurrenslähmungen Beitr z klin Chir, 1916, vol XCIX, pp 186-192
- ³ Schmerz, H Zur operativen Beeinflussung der Recurrenslähmung Beitr z klin Chir, 1919, vol CXVIII, pp 272-284
- ⁴ Guttman, V Sur l'etologie de la paralysie du nerf recurrent Arch internat de laryngol, 1923, vol XXXIX, pp 15-21
- ⁵ Payr Plastik am Schildknorpel zur Behebung der Folgen einseitiger Stimmbandlähmung Deutsche med Wchnschr, 1915, vol LI, pp 1265-1270
- ⁶ Schmieden, V Criticism and Recommendation of Payr's Laryngoplasty in Paralysis of Recurrent Nerve Munchen med Wchnschr, 1926, vol LXXIII, pp 558-559

CERVICAL RIB*

A METHOD OF ANTERIOR APPROACH FOR RELIEF OF SYMPTOMS
BY DIVISION OF THE SCALENUS ANTICUS

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INTRODUCTION

UNTIL recently the symptoms that accompany cervical rib have been attributed entirely to the presence of this anomaly. The relations of the scalenus anticus muscle to the anomalous rib have been defined anatomically, but they have not been considered surgically. We shall attempt to describe the anatomic distortion produced by a cervical rib directly and indirectly, and to justify anatomically and physiologically, as well as by presentation of results, a radical modification and simplification of previous methods of correcting that distortion and relieving symptoms.

HISTORY

Galen and Vesalius were the first to describe a cervical rib in detail. A cervical rib is a supernumerary rib, springing from one of the cervical vertebrae, usually the seventh, rarely the sixth, and very rarely the fifth. Helkiah Crooke, in his *mikrocosmographia* of 1651, mentions Bauhin finding thirteen ribs on each side at necropsy. Hunauld, the pioneer of our present conception, published his article in 1743. In 1818 A. Cooper was treating symptoms of cervical ribs medically with some success. Pilling reported 139 necropsy cases of cervical rib in 1860. In 1861 Coote performed the first operation and relieved the symptoms. Planet reports the second operation (by Perier in 1890), all symptoms were immediately cured. Fischer in 1892 operated on the third patient with success. Operation had been performed in eight cases by 1895.²⁵ In 1906 Keen reviewed all the cases in which operation had been performed to that time, numbering forty-two.

EMBRYOLOGY

Jones²⁰ attributes the embryologic formation of supernumerary ribs to a conflict between forming plexuses and ribs. The snake, without neck, waist, arms or legs, possesses two ribs for each vertebra with corresponding separate segmental nerves. In higher forms the limb buds appear as precursors to arms and legs. At first these buds cover several vertebral segments the nerves from which grow into the buds. However, the diametric growth of the limb buds does not keep pace with the longitudinal growth of the

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vertebral column and soon segmental nerves have to pursue an oblique course to enter the buds. Then begins the conflict between the obliquely running nerves and the newly forming ribs. The embryonic nerve trunks are far larger in proportion to the vertebrae and ribs of the embryo, than in the fully developed animal. The obliquely running nerves normally impede the growth of the ribs, so discouraging them that they merely form vertebral processes. Todd³⁰ states that ribs are normally present in the foetus in articulation with vertebrae above the eighth, and that after birth they are present only as transverse processes of the cervical vertebrae.

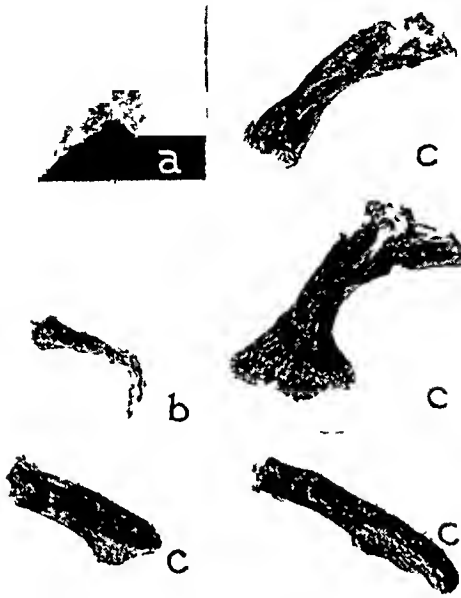


FIG. 1.—Surgical specimens of cervical ribs illustrating the different sizes and shapes under Gruber's classification. *a*, Group 2, *b*, Group 3, *c*, Group 4.

makes a considerable contribution to the brachial plexus. Todd believes that the vessels have equal importance with the nerves as causative factors in modifications of the upper end of the thorax.

ANATOMY

Comparative—Many variations in the number of ribs and situation of limbs are to be found in the evolution from snake to lizard. Cervical ribs are normal in crocodiles¹¹. The anthropoid ape has thirteen pairs of ribs. Adolph¹ found a dog with twenty-six ribs. Evolutionists assume that there is a tendency toward a shortening of the thorax, but there is no logical reason to be found for this. It is more probable that an increase or decrease from the normal number of ribs is anomalous.

Costal Anomalies in Man—Man has normally twelve pairs of ribs. Todd classifies the various anomalies in three groups: (1) Anomalies of the lower end of the thorax with increase or decrease in number of ribs, (2) anomalies of the upper end of the thorax with increase or decrease in the number of ribs, (3) anomalies of the upper and lower ends of the thorax. He finds no evidence that associated anomalies at both ends of the thorax are compensatory.

Anomalies of the upper end of the thorax reported run from rudimentary first ribs to double cervical rib on the same side of which at least three authentic instances have been noted²² Gruber, of St Petersburg, in 1869 classified cervical ribs in so complete a manner that his classification has never been improved. He divides them into four groups (1) Slight degree, cervical rib reaching beyond the transverse process, (2) more advanced, cervical rib reaching beyond the transverse process either with a free end or touching the first rib, (3) almost complete, the connection with the cartilage of the first rib being formed by means of a distinct band or by the end of the long body of the cervical rib, and (4) complete, the rib having become complete and possessed of a true cartilage which unites with the cartilage of the first rib (Figs 1, 2 and 3)

The complete cervical rib extends out laterally from the seventh lateral vertebral process for varying distances, then turns forward and downward between the scalenus anticus and scalenus medius muscles to meet the costal cartilage of the first rib. As the rib turns downward, the brachial plexus passes over it, then on its downward course the subclavian artery arches backward and laterally over it. Usually the scalenus anticus has attached itself to the cervical rib as the rib has pushed forward²⁶. Still lateral to the rib and outside of the scalenus anticus, arches the subclavian vein, lower than the artery. The muscle lies between the vein and the cervical rib. Above the vein and nearly over the rib, passing transversely across the shoulder, are to be found two branches of the thyroid axis, the suprascapular and transverse cervical. Above these arteries, running in the same general direction, is the inferior belly of the omohyoid muscle. The phrenic nerve passes downward along the anterior surface of the scalenus anticus, within the costal arch, usually out of danger, lies the carotid sheath with the common carotid artery, internal jugular vein, and the vagus nerve. Over all these structures, laterally and anteriorly, runs the lower end of the sternocleidomastoid muscle with the external jugular vein passing down its postero-external border.

If the rib is incomplete with a ligamentous band to the first rib, the course is very much the same. However, the scalenus anticus is less likely to be attached to the ligament. Shorter ribs are likely to run more laterally. Halbertsma states that if the cervical rib is 5.6 cm or more in length, the subclavian artery passes over it, if only 5.1 cm or less, the artery passes over the first dorsal rib. The pleura lies directly under the cervical rib, the pleural cavity having been increased by one intercostal space¹².

Murphy²⁷ states that if the rib is long enough the intercostal space between the cervical rib and the first dorsal rib is occupied by intercostal muscles and the vein and artery are exactly as in the thoracic intercostal spaces. Todd believes that the scalenes and intercostals are from the same muscle plane, forming two sheets, the inner forming the scalenus anticus and minimus, the outer the scalenus medius and posticus. These sheets of muscle are continued as the internal and external intercostals. The subdivisions of the scalenes are made by the passage of vessels and nerves. The course of

the subclavian artery through the scalenes corresponds to that of an intercostal artery through the chest-wall

Occurrence of Cervical Rib With Neuropathies and Congenital Deformities—Bassoe believes that cervical ribs belong to the so-called stigmas of degeneration and are features of an underlying neuropathic diathesis. Rosenhaupt states that cervical ribs are found in the progeny of persons with some physical degeneracy. At any rate, other congenital deformities are often associated with cervical ribs. Sherren knows of several instances



FIG. 2.—A completely formed right cervical rib with symptoms and an incompletely formed cervical rib on the left without symptoms

in which cervical ribs have been removed for symptoms due to syringomyelia. Many cases of the two being associated have been known. Borchardt observed the first. Whitman in 1905 presented a case of congenital deformity with extreme torticollis. Agassiz reports a case of cervical rib associated with congenital absence of the right thumb and scaphoid. Ballantyne

found a foetus with cervical rib, imperforate vagina and distention of the uterus. McGavin mentions an associated bony mass at the first chondrosternal junction. Renault and Romme had a case simulating cervical Pott's disease with malformation of the left foot, two nails on the second toe, atrophy of the fifth finger, two supplementary teeth, myopia and low intelligence. Poland's case was associated with club-foot. Copher reports a case of cervical rib without deformity of the scapula, but with a bony plate between the scapula and vertebrae, and spina bifida. Bassoe calls attention to Streissler's mention of cervical rib associated with spina bifida, harelip, crypto-orchidism, dislocated lens, club-foot, congenital lipoma, multiple sclerosis, syringomyelia, and muscular atrophy. No grounds can be found for Gaucher and Crouzon's opinion that cervical rib is an hereditary syphilitic dystrophy.

Familial Occurrence—Sufficient evidence is at hand to give credence to the statements of Bassoe and Rosenhaupt that cervical rib is an evidence of familial degeneracy. This is again borne out by Thompson's family of sixty-four individuals, representing five generations, in whom seven were affected with wasting of the hands, two of these examined by him having cervical ribs, by Wakeley's patient, whose sister also had cervical ribs, and by Weber's patient with cervical rib, whose brother and sister both had symptomless cervical ribs.

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INCIDENCE

Murphy²⁸ quotes Borchardt's statement that the incidence of cervical rib is 0.03 per cent. Fischel and Prague give the necropsy incidence as 0.1 per cent.¹³ Henderson in reviewing 80,000 routine examinations at the Mayo Clinic for five years ending in 1914, found thirty-one cases of cervical rib. Southam and Bythell examined roentgenograms of 2000 children more than fifteen months of age and found nine cases of cervical rib. In a study of 250 necropsy subjects, Todd found three cases of cervical rib and one of rudimentary first rib. Pilling in 1894 published an account of 139 cases of cervical rib found at necropsy, in three of these it had caused symptoms.

The occurrence of bilateral cervical rib lies between 67 and 80 per cent of all cervical ribs according to different opinions.^{7, 12, 18, 21, 25} In all of Sargent's twenty-nine cases bilateral abnormal ribs were present. Southam and Bythell found bilateral ribs in all of their cases. Murphy²⁸ states that but 30 per cent of bilateral ribs that give symptoms give bilateral symptoms. Complete bilateral ribs are very rare.^{7, 27} Up to 1907 Keen could find only two cases of complete bilateral ribs with bilateral symptoms. Among Pilling's 139 cases was one complete bilateral.

Two cervical ribs on the same side are extremely rare. Three authentic cases have been reported, one each by Beck, Ehrlich and Struthers.

Side Involved—The cervical rib is found more often on the left side, but symptoms are more common on the right side.²⁷ This is because of the greater use of the right arm, because the right plexus is in closer connection with the corresponding rib than the left, and because there is a greater drop of the right shoulder in the right-handed persons.⁴⁰ In Sargent's cases symptoms were usually on the side of the smaller rib.

SYMPTOMATOLOGY

Symptoms are much more common in women than in men. Evans gives the ratio of 3 to 1, Howell 14 to 2, Sargent 26 to 3, and Southam and Bythell 10 to 2. The preponderance of symptoms in women is hard to explain. Todd thinks that the greater movement of the upper part of the chest in women during respiration has much to do with it. Evans suggests that deformities in the neck are more noticeable in women. Childbirth and the greater susceptibility of women to the common causes of onset of symptoms, rapid loss of weight, chronic nervous exhaustion, and general ptosis, are certainly important factors as is the greater drooping of the shoulder girdle in women.

Onset of Symptoms—Cervical ribs have been recognized in children by the presence of a tumor in the neck. Stiles had a patient eighteen months of age. A boy aged seven was brought to Barling with complaint of tumor. Murphy and Donaldson thought the most common age was from twelve to eighteen. Beck thought the symptoms were first manifested after the age of twenty. Evans between twenty and thirty. Howell reported ten of a series of sixteen to be under thirty. In a group reported by Sargent the

average age was thirty-eight and seven-tenths years, the youngest thirteen, the oldest sixty-two

Characteristic Symptoms—Many symptoms may be attributed to a cervical rib, especially by patients who have been informed of its presence, but the characteristic symptoms are one or more of the following pain, atrophy, circulatory abnormalities and disturbance of sensation

Pain is felt along the inner side of the arm, over the distribution of the internal cutaneous, the ulnar, and the median nerves and, occasionally, over



FIG 3 —Completely formed bilateral cervical ribs with symptoms on both sides

the distribution of the entire brachial plexus. The pain may be sharp and lancinating and may be brought on by sudden rotation of the head or by a forceful, downward pull of the shoulder. Sometimes it is dull, aching, burning, and boring in character, and occurs during the latter part of the day, after the patient has been working for a time, especially in the case of housewives after sweeping, washing, or dusting. The pain may be associated by hyperaesthesia, paræsthesia, or anæsthesia, depending on

the degree of involvement, affecting chiefly the distribution of the middle and lower cervical trunks. This is usually referred to as tingling, burning, and numbness along the inner side of the arm, hand, and fingers.

Atrophy is late to occur, and is rarely complete. In 1905, Thorburn reported two cases of atrophy of the intrinsic muscles of the hand associated with cervical rib. Jones²¹ in reporting a series of fourteen cases of atrophy of the intrinsic muscles of the hand, found cervical ribs present in ten on Röntgen-ray examination. Wilson finds atrophy to be of two types: the median or partial thenar type and the ulnar type. In the former there is paralysis of the abductor pollicis, and the opponens pollicis, supplied from the seventh cervical nerve. The remaining thenar muscles are intact. The flexor brevis pollicis is also supplied from the median nerve, but probably from a different segment. The ulnar type ("main-en-griffe") in which there may be paralysis of all the muscles of the hand except the two just mentioned, is the result of injury of the eighth nerve.

Circulatory symptoms are rarely severe, but they may manifest them-

selves in a dusky hue of the arm and hand, as compared with the opposite upper extremity, associated with mild trophic changes in the tips of the fingers. Several cases have been reported in which gangrene of one or more fingers occurred. In this event obliteration of either the radial or the ulnar artery, or of both, usually occurs also. Diminution in volume of the radial pulse is common, the pulse can be decreased or obliterated by having the patient elevate the chin or rotate the head to the affected side while inspiring air. These symptoms vary in degree, according to the amount of pressure over the subclavian artery. Occasionally, the pulsating subclavian may be seen or palpated above the clavicle, occasionally, too, aneurism of the subclavian is said to occur, but we have not observed this in our series. The presence of Horner's syndrome has been described in cases of cervical rib.

The circulatory changes are caused by constriction of the subclavian artery or subclavian vein, obstruction of the radial and ulnar arteries by emboli from thrombosis at the site of constriction, or possibly by disturbance of the sympathetic innervation.

Horner's syndrome may be due to pressure and traction on the inferior cervical ganglion. Bernhardt refers to Fischer's case of choking, and Dejerine reports a case with paræsthesia and definite loss of sensation over the distribution of the fifth and sixth cervical nerves which was relieved by operation. Similar relief was obtained by a patient of ours, a girl aged nineteen, with an exceedingly long neck and a marked downward course of the brachial plexus, which resulted in mesial displacement of the brachial plexus to the lateral edge of the cervical rib and subjected the entire brachial plexus to trauma by the scalenus anticus muscle. Evans believes that a short rib may lie close to the carotid sheath and produce disturbance of the vagus and of the recurrent laryngeal nerve. In one of the cases in our series there was a reflex cough every ten or fifteen seconds, thus relieved by dividing an anomalous twig from the phrenic nerve. The brachial symptoms were relieved by tenotomy of the scalenus anticus muscle. Garié believes that scoliosis is due to unequal development of cervical ribs.

SURGICAL CONSIDERATIONS

Surgical treatment should be considered (1) if the patient complains of pronounced pain or of sensory or circulatory disturbance sufficient to incapacitate him, (2) if the patient presents evidence of atrophy in the arm or hand of the affected side, and (3) if there is evidence of circulatory disturbance on the affected side, especially if the pulse at the wrist can be obliterated or markedly reduced by extending the neck or rotating the head, even though the brachial symptoms are only slight.

Surgical treatment may be indicated and should be considered (1) in a group of anomalies in the supraclavicular triangle which gives rise to symptoms similar to those produced by a cervical rib, and (2) in cases of mild paræsthesia, but if there is an underlying neurotic tendency, operation should be advised cautiously and left to the patient's option.

Surgical treatment is not indicated if cervical ribs are found accidentally and the patient is free from specific symptoms. It is well to refrain from informing the patient of this finding, for fear of precipitating neurosis based on the consciousness of it (Figs 4, 5, 6, 7)

SURGICAL TECHNIC

A cervical rib has generally been removed by the midcervical or post-brachial approach, an attempt being made to remove or resect the rib and to divide any bands which might be present after the cervical trunks and the brachial plexus had been displaced forward. This procedure involves considerable traction on the nerve trunks, which too frequently produces obstinate anaesthesia and palsy. Moreover, it has been difficult by means of the posterior approach to disarticulate complete cervical ribs because of the close proximity of the subclavian artery, which frequently rests on the cervico-thoracic articulation.

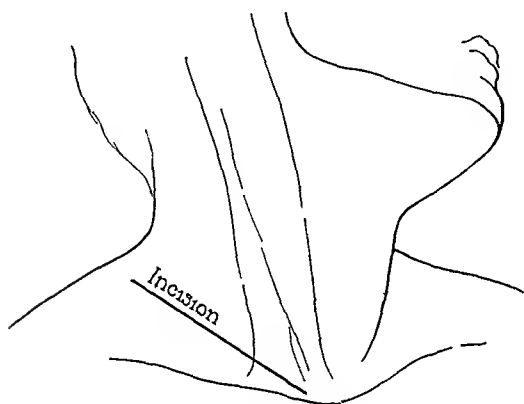


FIG 4 —The incision employed

For these reasons, we employed the anterior transbrachial approach to the cervical rib. The incision is somewhat similar to that used for the mid-cervical approach, except that it

extends forward and mesially over the sternoclavicular articulation and thus permits mesial reflection of the clavicular attachment of the sternocleidomastoid. The fat and subcutaneous tissue in the supraclavicular triangle are reflected upward and laterally, the omohyoid muscle is divided laterally, the dissection is then carried upward into the lower border of the posterior triangle. We expose at this plane the carotid sheath mesially, the anterior surface of the scalenus anticus muscle with the phrenic nerve passing across the anterior surface of this muscle, the lateral portion of the subclavian artery (which takes a forward and lateral course from underneath the tendinous attachment of the scalenus anticus muscles) and the brachial plexus. The transverse cervical and suprascapular arteries are divided and ligated during the dissection. On observing the relation of the tendinous attachment of the scalenus anticus muscle, the subclavian artery and the brachial plexus near the cervical rib, one is able to demonstrate how the scalenus anticus muscle compresses the subclavian artery from one-half to one-third its normal size, this pressure is transmitted posteriorly and laterally by the subclavian artery to the lower and middle trunks of the brachial plexus as they lie on the cervical rib. The degree of compression depends directly on the width of the scalenus anticus attachment and the angle of the cervical rib, which determines the width of the space between the lateral portion of the muscle and the rib (Figs 8 and 9).

Prior to the removal of the cervical rib, tenotomy is performed on the

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scalenus anticus tendon right at its attachment, permitting it to retract and to be elevated mesially for exposure of the subclavian artery in the supra-clavicular triangle. The subclavian artery is then dissected free, this usually remains constricted, even though released. In the two cases of gangrene of the fingers, there were calcareous deposits in the wall of the subclavian artery at the point of constriction. Following tenotomy, the seventh and

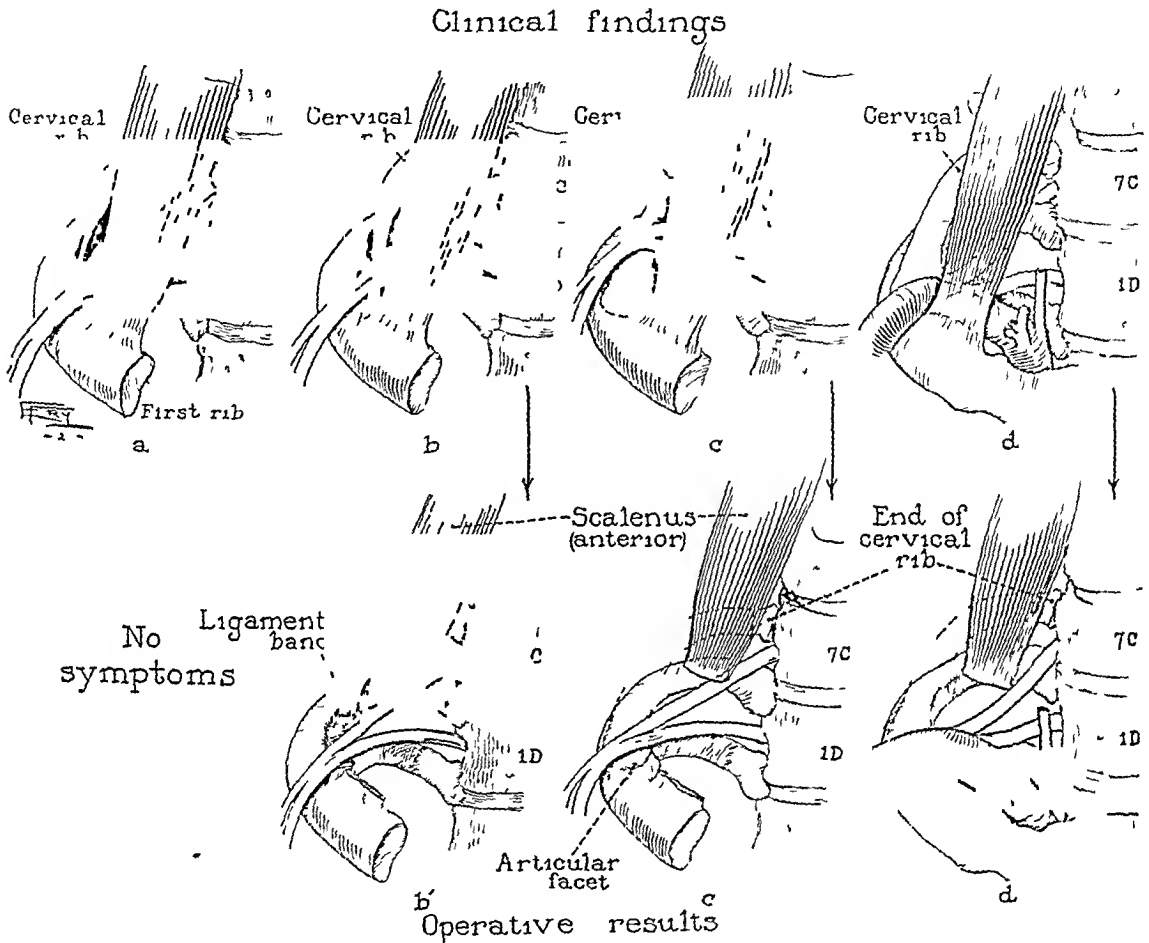


FIG. 5—*a* The presence of a cervical rib with a fibrous band between the cervical rib and the thoracic rib, without the production of symptoms due to ample space between the lateral border of the scalenus anticus muscle and the ligamentous band of the cervical rib. *b* Compression of the lower trunk of the brachial plexus by the scalenus anticus against the fibrous band. *b'* Relief of compression by tenotomy of the scalenus anticus and division of the fibrous band. *c* Compression of the lower trunk of the brachial plexus by the scalenus anticus against the completely formed cervical rib. *c'* Relief of compression by either tenotomy of the muscle or resection of the rib. *d* Compression of the lower trunk of the brachial plexus and the subclavian artery against the completely formed cervical rib. *d'* Relief of compression by tenotomy of the scalenus muscle or by resection of the cervical rib.

eighth cervical and first dorsal roots are dissected free, care being taken not to injure the vertebral artery or the inferior thyroid, which lie along the mesial side of the field, anterior to the transverse process of the seventh cervical vertebra. The next step is to elevate the seventh cervical root upward and backward with a tape about the nerve, and to retract the inferior trunk downward. This permits excellent exposure of the spinal articulation of the cervical rib. The dissection of the rib is then carried laterally and downward between the seventh and eighth cervical roots for a distance of about 4 cm., when the inferior trunk is retracted with the middle trunk upward and backward, and the subclavian artery is retracted forward and mesially to expose the articulation of the cervical rib on the first thoracic

The dissection with the disarticulation is then completed and the rib removed through the latter exposure

In the transcervical or the postbrachial approach, the surgeon is usually content with elevating the brachial plexus and removing the rib, or as much of it as is possible, from behind, without exposing the scalenus anticus muscle, the subclavian artery, or other tissues in front. Because of the occasional post-operative palsy which ensued and the greater ease in operation, one of us (Adson) was persuaded to use, and subsequently to adopt, the anterior approach, in which the clavicular attachment of the sternocleidomastoid muscle is reflected to expose the scalenus anticus muscle, the subclavian artery, and the brachial plexus. One can readily observe the pressure produced by the scalenus anticus muscle when the neck is extended backward or the head is rotated toward the affected side.

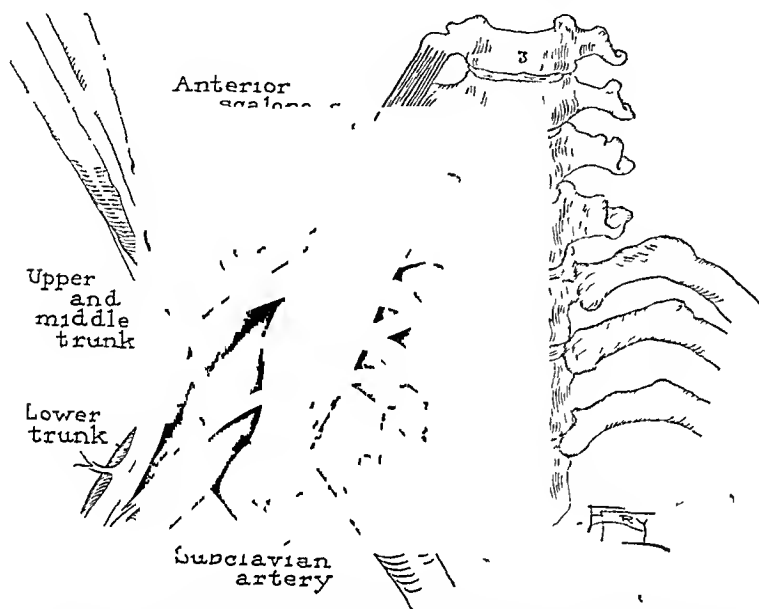


FIG. 6.—Illustrating the compression not only of the subclavian artery and the lower trunk but irritation of the entire brachial plexus by the scalenus anticus against the completely formed cervical rib

After having removed several ribs according to this technic, and having studied the mechanics which produce the symptoms, we were convinced that, with the exception of the one case previously referred to, removal of the cervical rib was really unnecessary, inasmuch as the subclavian artery and the brachial plexus were immediately relieved from pressure and irritation upon severance of the scalenus anticus muscle from its insertion. The latter procedure was much less difficult and more effective since the subclavian artery was then permitted to recede and take on its normal size, provided operative treatment was instituted before any permanent change had taken place. All traction on the brachial plexus is removed by the tenotomy of the scalenus anticus muscle.

The ulnar nerve rides over a bony prominence where it is constantly subjected to motion without symptoms being provoked, there should be no more likelihood of symptoms arising in the brachial plexus when it merely lies on the cervical rib, with little or no motion and no traction on it. Accordingly, we have operated on four patients by means of the anterior approach, dividing the tendinous attachment of the scalenus anticus muscle without removing the cervical rib, symptoms were completely relieved.

REVIEW OF CASES

In reviewing the histories of a series of 540,413 new patients registered at the Mayo Clinic between January 1, 1910, and October 1, 1926, we find 303 cases in which cervical rib was diagnosed. This represents an incidence of 0.056 per cent.

Of these patients, eighty-four were males, and 219 were females. Röntgen-ray examination revealed a cervical rib on the right in seventy, a

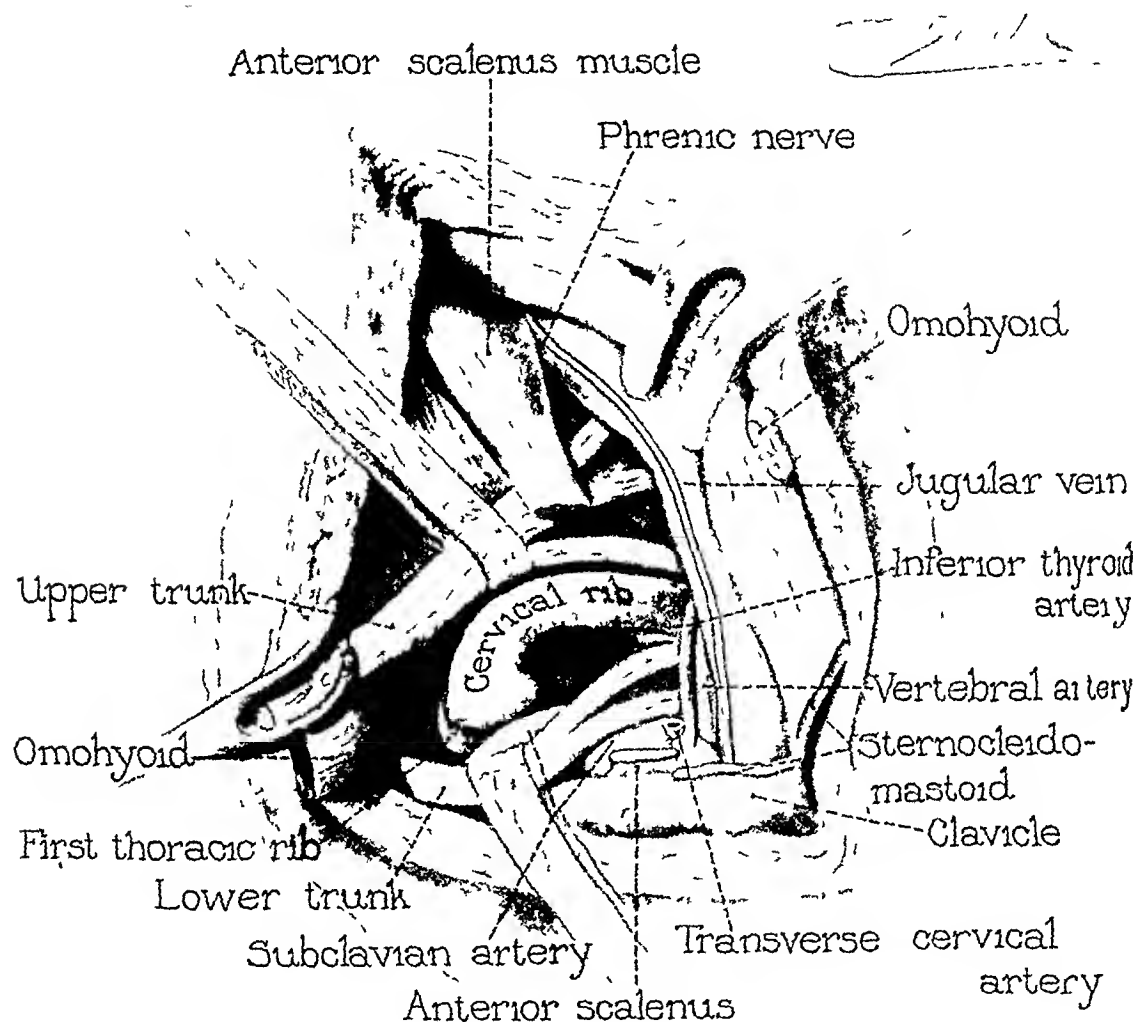


FIG. 7.—The anterior approach to the cervical rib when resection is advisable.

cervical rib on the left in ninety-one, and bilateral cervical ribs in 143. In cases of unilateral cervical rib, there frequently exists a supernumerary costal tubercle on the opposite side, which does not extend beyond the transverse process of the cervical vertebra and is, therefore, not classified as a cervical rib, it would fall, however, in the first group of Gruber's classification.

In 167 of this group (55 per cent) the presence of cervical ribs was discovered accidentally, there being no symptoms. In 100, although the radiograms were positive, the symptoms were mild and of such a character that we deemed surgical treatment inadvisable, in seventy-seven of the 100 there was indefinite pain in the neck and shoulder, radiating only slightly down the arm and hand, in five the pain was localized and radiated along the ulnar

nerve, in two it radiated along the course of the internal cutaneous nerve, and in four it radiated definitely over the brachial plexus, but was not severe. In twelve cases the pain was exaggerated by rotating the head, or by elevating the chin. Slight atrophy was observed over the ulnar distribution in twelve. Subjective anæsthesia was present in the ulnar distribution in seven, in the internal cutaneous in two, and in the brachial distribution in four. Circulatory disturbance was present in four. The patients presenting slight atrophy and subjective anæsthesia will seek surgical interference, no doubt, sooner or later.

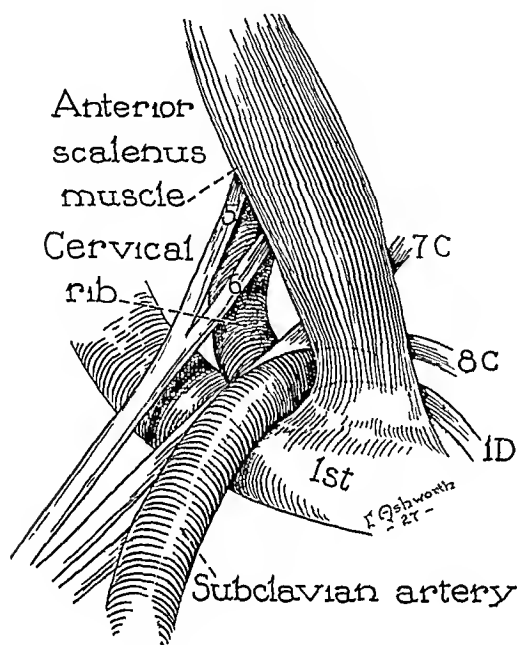


FIG. 8.—Wide insertion of the scalenus anticus with resultant compression of the subclavian artery and inferior and middle trunks of the brachial plexus.

SURGICAL CASES—Surgical treatment was administered in thirty-six cases, there were eleven males, and twenty-five females. In fifteen cases symptoms were confined to the right side, in eighteen to the left side, and in three they were bilateral. Diffuse, darting, and aching pain was present over the brachial distribution in twenty-six, in twenty-two the pain radiated definitely over the ulnar distribution, and in nineteen over the internal cutaneous nerve. Subjective or objective sensory disturbance was present in the brachial distribution in nine, in the ulnar in eleven, and in the

internal cutaneous in six. Atrophy was present in the ulnar distribution in eight, and circulatory phenomena, consisting of vasomotor changes, cyanosis, trophic disturbances of the finger tips, and impaired pulse volume on the affected side in thirteen. In two cases gangrene had affected the finger tips. The pain in the shoulder and the arm was occasionally relieved by elevating the shoulder on a pillow.

The transcervical approach, posterior to the brachial plexus, was used in twenty-three cases, the anterior approach, as described in the present technic, was used in thirteen. Complete relief from symptoms was afforded in twenty-six, and partial relief in four, failure of relief was reported in six. Of the six failures, the anterior approach was followed in one case. In this case, the rib was completely removed, and the persistence of symptoms was due probably to the fact that many of the indefinite pains of the neck and shoulder were not caused, primarily, by the presence of the cervical rib, especially since the nervous system was unstable and many other symptoms were complained of.

The post-operative course in eight of the cases in which operation followed the posterior approach was complicated by numbness, and in four by

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slight palsy In two of the cases in which the anterior approach was employed, the pleura was accidentally opened to the size of a pin point, but sufficiently to produce partial pneumothorax While this accommodated itself in a few days, it was of sufficient moment to warn the surgeon of the possibility of injury to the pleura, when dividing the scalenus anticus muscle, as the pleura frequently extends into the supraclavicular triangle in cases of cervical rib

In two of the cases of bilateral cervical rib, there were marked symptoms

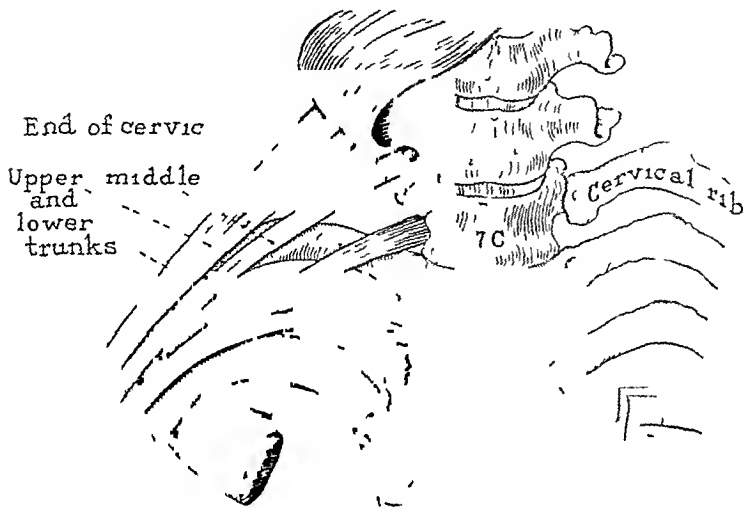


FIG. 9.—Illustrating the relief from compression of the lower and middle trunks of the brachial plexus and the subclavian artery with recession of the subclavian artery following tenotomy of the insertion of the scalenus anticus

on the right side Both of these patients were men, and both were laborers, one aged thirty-four and the other thirty-three In both there was gangrene of the fingers, in one it had affected the third and fourth fingers in the other the second and third fingers The subclavian artery in both of these cases was found to be markedly compressed, remained

kinked, and failed to dilate after division of the scalenus anticus muscle Due to the changes in the wall of the artery, the vessel felt calcareous and pipestem-like In both cases the anterior approach was followed

In one of the cases the radial and ulnar pulse was perceptible, but was greatly reduced in volume Prior to the patient's dismissal, following removal of the cervical rib, it was deemed advisable to amputate the tips of the two gangrenous fingers

In the second case not only was the subclavian artery sclerosed, but the radial and ulnar pulses were obliterated The immediate convalescence following division of the scalenus anticus muscle and resection of the cervical rib was uneventful After primary union of the wound, the patient was dismissed from the hospital The operation was performed June 30, 1925 July 9, after having been dismissed from the hospital, the patient suddenly experienced a severe pain in the neck, in the region of the wound, and we discovered an extensive hæmatoma developing underneath the skin The wound was promptly opened, and the subclavian artery was found to be bleeding profusely We controlled the bleeding by the use of a muscle slab over the opening in the subclavian artery and packs until July 15, when a second hemorrhage occurred We then exposed and ligated the subclavian artery, but the patient succumbed later to the effects of the hemorrhage despite transfusion and other emergency measures

CAUSE OF SYMPTOMS—Todd believes that the symptoms are due to the

diminished obliquity of the thoracic operculum, the distance of the inner border of the first rib from the median line of the body assisted by the relative widening of the shoulder girdle, the growth of the clavicle, and the sinking of the shoulder girdle. His original statement in 1911,⁴⁰ "Arterial symptoms are caused by the action, directly by the scalenus and indirectly by the diaphragm, on an artery with a further and more tortuous course to pursue," was modified in 1912⁴¹ when he asserted that the contracting scalenes muscles cannot compress the subclavian artery. He further stated

"The vascular symptoms occurring in cases of so-called cervical rib are not mechanical in origin, but are trophic in character and are caused by paralysis of the sympathetic fibres passing to the vessels. The same nerve which supplies the skin and muscles supplies the vessels, and hence trophic changes occur in the same area in either vessels or muscles or skin."⁴¹



FIG. 10.—Completely formed right cervical rib presenting an articular joint in the middle and an incompletely formed cervical rib on the left. In this case the symptoms were right sided and were associated with reflex cough.

It is difficult to explain on one hypothesis

(1) the compression of the artery (which is observable at operation and is not to be attributed to formalin fixation of the cadaver), (2) diminution of pulse volume in the vessels of the affected arm, (3) cyanosis of the skin of affected arm (in some cases), (4) variability of this pulse volume and cyanosis when scalene muscles are put on tension by suitable movements, (5) pathologic changes in subclavian artery where it crosses anomalous rib, (6) pathological changes in distal arteries and arterioles, and (7) gangrene of fingers.

Clinically, we were able to demonstrate the influence of the scalenus anticus muscle by having the patient elevate the chin and extend the neck or rotate the head to the affected side while taking a deep inspiration, this produces paræsthesia over the distribution of the brachial plexus and, frequently, obliteration of the pulse at the wrist on the affected side. This was well illustrated in the case of a railroad engineer, who complained of paræsthesia in the right arm, chiefly over the distribution of the ulnar and median nerves, in conjunction with cyanosis of the arm and hand. These symptoms were initiated when, at work, he was compelled to look backward through the cab window, if it was necessary for him to do so for any appreciable length of time, the right hand and arm became so numb and weak that he was unable to use them. The arm also became more cyanosed.

CERVICAL RIB

When it is considered that the subclavian vein is beyond the field of possible compression by the scalenus anticus, Todd's argument concerning the influence of disturbance of the sympathetic innervation seems essential to the explanation of the symptoms, especially the cyanosis. It is impossible to concur in his opinion, however, that this disturbance amounts to paralysis, in the face of the alterability of pulse volume and cyanosis by such clinical tests as we have described. If he is justified in attributing the pathologic changes in the distal vessels to disturbance of sympathetic innervation, and if the histologic picture which he has described can be observed with any constancy in cases of cervical rib, a clearer light will be thrown on the cause and nature of the thromboangitis obliterans.

However valid the hypothesis of disturbance of sympathetic innervation, we believe that insufficient emphasis has been placed on the influence of the scalenus anticus muscle which produces compression of the subclavian artery and of the brachial plexus against the cervical rib.

During the height of muscular development the belly of the scalenus anticus muscle compresses the subclavian artery and the lower trunk of the brachial plexus to a greater degree than during childhood or the later periods of life, this we believe accounts for the symptoms during this period. It is true also, that during this period of life the individual carries out the greatest physical efforts, placing a greater strain on the shoulder, this in turn causes the shoulder girdle to drop. This explains the greater frequency of right-sided symptoms in the presence of bilateral ribs, inasmuch as most people are right-handed and tend to lift the heavier weights with the right hand.

The infrequency of symptoms in the presence of cervical ribs is explained,

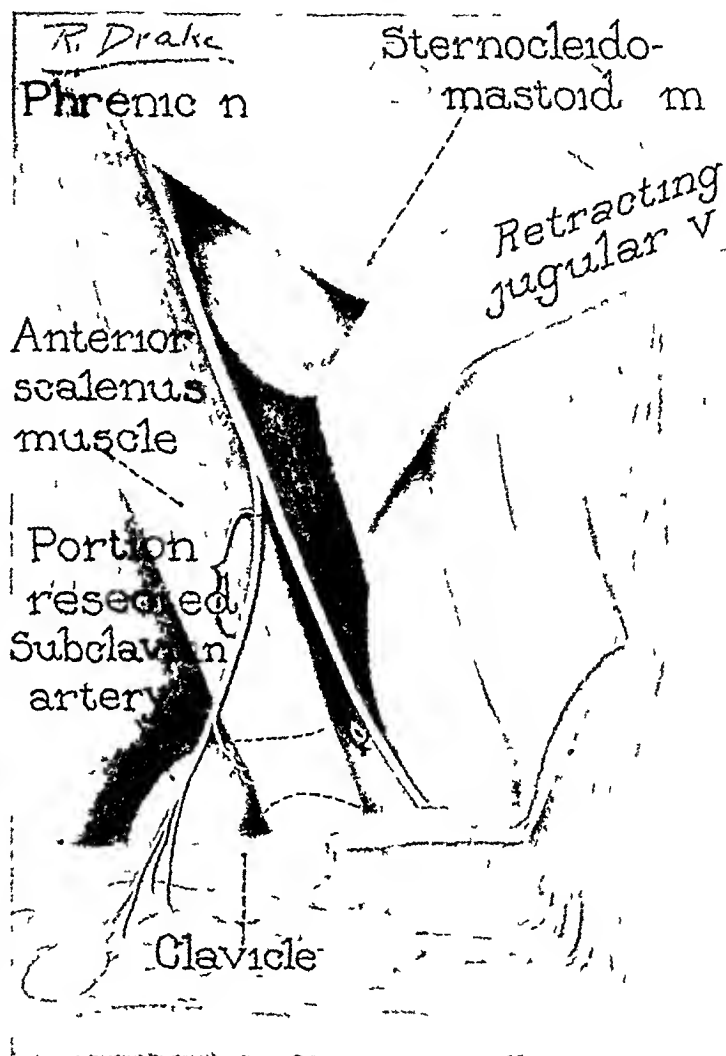


FIG. 11.—In this case brachial and vascular symptoms were relieved by tenotomy of the scalenus anticus muscle and the reflex cough by resection of the anomalous sensory branch of the phrenic nerve.

we believe, by an additional factor which we have observed in the exploration of cervical ribs with reference to the tendinous insertion of the scalenus anticus muscle. In cases associated with circulatory disturbance and brachial symptoms insertion is invariably wide, the muscle is reflected laterally beyond the operculum to and onto the cervical rib, this narrows the space between the lateral border of the scalenus anticus muscle and the cervical rib, and accounts for the pressure symptoms. In the absence of symptoms, the insertion is found more mesially in a narrower band, and a wider space is thus afforded between the lateral border of the scalenus anticus muscles and the cervical rib. It is obvious that if the rib takes a wide, lateral course before it turns forward and downward, the space between the rib and the scalenus anticus muscle is ample for the descent of the subclavian artery on the lower trunk of the brachial plexus without pressure. The observations which we have made have been facilitated perhaps by the anterior method of approach, which we have employed for exposure of the brachial plexus.

In view of our convictions concerning the influence of the scalenus anticus muscle in compressing the subclavian artery, and the inferior and middle trunks of the brachial plexus, we present the following case.

ILLUSTRATIVE CASE

The patient was a housewife, aged fifty-three, and the mother of four children. The medical history was negative except for the current complaint, which had begun one year before, of pain in the posterior cervical triangle, with radiation to the shoulder. For four weeks previous to admission, spontaneous, hacking, reflex cough had been occurring every few seconds.

The physical examination, the laboratory tests, and the neurologic investigation were negative except for symptoms referable to the complaint. A cervical rib could be palpated on the right. A bruit was present over the right subclavian artery. The pulse in the wrist was interrupted by extension of the neck in conjunction with inspiration, this also caused exaggeration of the pain and radiation into the arm. The roentgenogram revealed bilateral cervical rib. On the right the rib was completely formed and jointed, it was incompletely formed on the left (Fig 10). The possibility of aneurism was ruled out by physical and radiologic examinations. Exploration of the right cervical rib was advised. The patient was informed in advance that probably two operations would be necessary, since we intended only to divide the scalenus anticus muscle at the first operation and to remove the rib at the second operation, if the symptoms persisted. During exploration of the scalenus anticus muscle through the anterior approach, it was observed that, although the phrenic nerve took its normal course, there was an additional branch which turned obliquely outward at a point 5 cm above the costal attachment of the scalenus anticus muscle (Fig 11), crossed the subclavian artery, and was adherent to it just lateral to the scalenus anticus muscle. This branch was slightly smaller than the usual size of the phrenic nerve and extended from a mass of adhesions over the subclavian artery in the subareolar tissue above the clavicle, apparently as one of the supraclavicular sensory nerve fibres, in all probability it was a continuation of the fourth or fifth cervical sensory fibres. The anomalous nerve was resected, the phrenic nerve being left undisturbed, and tenotomy of the scalenus anticus muscle at its insertion on the thoracic rib was performed. Following this, we dissected free the subclavian artery and the two lower trunks of the brachial plexus. The rib was prominent behind the brachial plexus, but immediately on division of the scalenus anticus muscle there was no further pressure either on the vessels or on the nerves, and the wound was

CERVICAL RIB

closed expectantly without removal of the cervical rib. The reflex cough was relieved completely and all pain in the neck, shoulder, and arm disappeared. The patient was dismissed after an uneventful convalescence, without removal of the cervical rib.

In view of the gratifying result obtained in this case, we have followed the same procedure in four cases since in which symptoms were referable to a cervical rib. The results have been as good following simple division of the scalenus anticus muscle as they were after removal of the cervical rib, and trauma to the brachial plexus was avoided. Therefore, we feel justified in advocating the anterior approach and division of the scalenus anticus muscle without removal of the cervical rib.

CONCLUSIONS

1 In about 55 per cent of the cases reviewed in our series, the cervical ribs were symptomless.

2 Patients with cervical ribs without symptoms should not be informed of the accidental finding, as this may give rise to neurosis with symptoms referable to the rib.

3 The surgical indications depend directly on the degree and the type of the incapacity produced by the presence of pain, hyperæsthesia, anæsthesia, and circulatory disturbance. Surgical treatment should not be advised for mild, indefinite pain in the neck and shoulder.

4 The anterior approach and tenotomy of the scalenus anticus muscle are preferable to the transcervical approach and resection of the cervical rib, since the same relief is offered, the procedure is less formidable and post-operative numbness in the arm and palsy of the brachial plexus are avoided.

BIBLIOGRAPHY

- ¹ Adolphi, H. A. Ueber ein Hundeskelet mit sogenannten Halsrippen bei nur 26 Praesacralwirbeln. *Morph. Jahrb.*, 1902, vol. xxx, p. 374.
- ² Agassiz, C. D. S., and Sykes, K. A. H. Cervical Ribs in Children. *Brit. Med. Jour.*, 1925, vol. 1, pp. 71-72.
- ³ Barling, Seymour. Note on a Case of Bilateral Cervical Rib in a Child. *Brit. Jour. Child Dis.*, 1910, vol. vii, pp. 108-109.
- ⁴ Bassoe, Peter. The Coincidence of Cervical Ribs and Syringomyelia. *Arch. Neurol. and Psychiat.*, 1920, vol. iv, pp. 542-545.
- ⁵ Beck, Carl. Die chirurgische Bedeutung der Halsrippe. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1904-1905, vol. viii, pp. 43-47. Translation, *Jour. Am. Med. Assn.*, 1905, vol. xlv, pp. 1912-1915.
- ⁶ Borchardt, M. Symptomatologie und Therapie der Halsrippen. *Verhandl. d. Berl. med. Gesellsch.*, 1902, vol. xxxii, pp. 431-448. *Berl. klin. Wchnschr.*, 1902, vol. xvi, pp. 157-175.
- ⁷ Copher, G. H. Deformity of Scapulæ Associated with a Cervical Rib and a Spina Bifida. *ANNALS OF SURGERY*, 1919, vol. lxi, pp. 644-646.
- ⁸ Coote, Holmes. Pressure on the Axillary Vessels and Nerve by an Exostosis From a Cervical Rib, Interference with the Circulation of the Arm, Removal of the Rib and Exostosis, Recovery. *Med. Times and Gaz.*, 1861, vol. ii, p. 108.
- ⁹ Donaldson, Robert. Notes on Double Cervical Rib, with an Illustrated Case. *Brit. Med. Jour.*, 1909, vol. ii, pp. 931-932.
- ¹⁰ Ehrlich, E. Zur klinischen Symptomatologie der Halsrippen. *Beitr. z. klin. Chir.*, 1895, vol. xiv, pp. 199-228.

- ¹¹ Eisendrath, D N The Existence of Cervical Ribs in Man *Am Med*, 1904, vol viii, pp 322-325
- ¹² Evans, E S Cervical Rib *Jour Am Med Assn*, 1912, vol lviii, pp 1111-1112
- ¹³ Fischel and Prague (Quoted by Southam and Bythell)
- ¹⁴ Fischer, Georg Extirpation einer Halsrippe wegen Drucks auf den Plexus brachialis *Deutsch Ztschr f Chir*, 1892, vol xxxiii, pp 52-56
- ¹⁵ Gaueher, E, and Crouzon, O Une observation de côtes cervicales d'origine heredo-syphilitique *Bull et mem Soc med d hop de Par*, 1913, vol xxxvi, pp 98-100
- ¹⁶ Gruber, W Ueber die Halsrippen des Menschen mit vergleichend-anatomischen Bemerkungen, St Petersburg, 1869
- ¹⁷ Hendeison, M S Cervical Rib Report of Thirty-one Cases *Am Jour Orthop Surg*, 1913-1914, vol vi, pp 408-430
- ¹⁸ Howell, C M H A Consideration of Some Symptoms Which May be Produced by Seventh Cervical Ribs *Lancet* 1907, vol i, pp 1702-1707
- ¹⁹ Hunauld Sur le nombre des cotes, moindre ou plus grand qu' a l'ordinaire *Hist Acad roy d sc de Paris*, 1740
- ²⁰ Jones, F W The Anatomy of Cervical Ribs *Proc Roy Soc Med*, 1912-1913, vol vi, Clinical Section, pp 95-113
- ²¹ Jones, H L Cervical Ribs and their Relation to Atrophy of the Intrinsic Muscles of the Hand *Med Electrol, and Radiol*, 1906, vol viii, pp 202-205 *Quart Jour Med*, 1907-1908, vol i, pp 187-191
- ²² Kammerer, Frederick Cervical Ribs *ANNALS OF SURGERY*, 1901, vol xxxiv, pp 637-648
- ²³ Keen, W W The Symptomatology, Diagnosis, and Surgical Treatment of Cervical Ribs *Am Jour Med Sc*, 1907, vol cxliii, pp 173-218
- ²⁴ McGavin, Lawrie Bilateral Cervical Ribs, and an Abnormal Bony Mass at the First Chondrosternal Junction *Tr Clin Soc London* 1901-1902, vol xxxv, p 179
- ²⁵ Moore, C A A Case of Subclavian Aneurism with Cervical Ribs *Lancet*, 1922, vol i, pp 1045-1046
- ²⁶ Murphy, J B A Case of Cervical Rib with Symptoms Resembling Subclavian Aneurism *ANNALS OF SURGERY*, 1905, vol xli, pp 399-406
- ²⁷ Murphy, J B The Clinical Significance of Cervical Ribs *Surg, Gynec and Obst*, 1906, vol iii, pp 514-520
- ²⁸ Murphy, J B Cervical Rib Excision Collective Review on Surgery of Cervical Rib *Surg, Clin*, 1916, vol v, pp 227-240
- ²⁹ Phinet, Abel Tumeurs osseuses du cou, la septieme cote cervicale *Paris*, 1890, Steinheil, 40 pp
- ³⁰ Poland, Alfred On a Case of Fusiform and Tubular Aneurism of the Subclavian Artery and its Successful Treatment by Indirect Digital Compression *Medico-Chir Tr*, 1869, vol lii, pp 275-302
- ³¹ Renault, Jules, and Romme Un cas de cote cervicale supplementaire simulant le mal de Pott cervical *Arch de med d enfants*, Paris, 1918, vol xxi, pp 83-85
- ³² Rosenhaupt, Heinrich Zur Klinik der Halsrippe *Arch f Kinderh*, 1905, vol xli, pp 205-208
- ³³ Sargent, Percy Some Points in the Surgery of Cervical Ribs *Proc Roy Soc Med*, 1912-1913, vol vi Clinical Section, pp 117-126
- ³⁴ Sherren, J Cervical Ribs, Involvement of Superficial Nerves in Scar-tissue Following their Removal Syringomyelia in a Patient with Cervical Ribs *Clin Jour*, 1908, vol xxxii, pp 95-96
- ³⁵ Southam, A H, and Bythell, W J S Cervical Ribs in Children *Brit Med Jour*, 1924 vol ii, pp 844-845
- ³⁶ Struthers, J On Variations of the Vertebrae and Ribs in Man *Jour Anat and Physiol*, London, 1874-1875, vol ix, pp 17-96

- ²¹ Thompson, Theodore Familial Atrophy of the Hand Muscles *Bram*, 1908, vol. xxxi, pp. 286-300
- ²² Thorburn, William The Seventh Cervical Rib and its Effects Upon the Brachial Plexus *Med Chir Tr*, London, 1905, vol. lxxviii, pp. 109-125
- ²³ Todd, T W Cervical Rib Factors Controlling Its Presence and Its Size, Its Bearing on the Morphology of the Shoulder, with Four Cases *Jour Anat and Physiol*, London, 1911-1912, vol. xlv, pp. 244-288
- ²⁴ Todd, T W The Relations of the Thoracic Operculum Considered in Reference to the Anatomy of Cervical Ribs of Surgical Importance *Jour Anat and Physiol*, London, 1911, vol. xlv, pp. 293-304
- ²⁵ Todd, T W The Arterial Lesion in Cases of Cervical Rib *Jour Anat and Physiol*, London, 1912-1913, pp. 250-253
- ²⁶ Wakeley, C P G Gunshot Wound of Forearm Masking Symptoms of Cervical Rib *Brit Jour Surg*, 1920-1921, vol. viii, pp. 226-227
- ²⁷ Weber, F P Cervical Ribs with Atrophy of Hand Muscles *Proc Roy Soc Med*, 1912-1913, vol. vi, Clinical Section, pp. 55-57
- ²⁸ Wilson, S A K Some Points in the Symptomatology of Cervical Rib, with Especial Reference to Muscular Wasting *Proc Roy Soc Med*, 1912-1913, vol. vi, Clinical Section, pp. 133-141

BRACHIAL PLEXUS PRESSURE BY THE NORMAL FIRST RIB*

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FAIRLY familiar now is the phenomenon of pressure on the brachial plexus or, sometimes, on the subclavian artery, by a supernumerary (cervical) rib or by a band extending from the end of a rudimentary cervical rib. That the same pressure on the plexus may also be produced by an entirely normal first thoracic rib has been recognized by some of our colleagues in Great Britain and Australia. I have found in the literature of no other country, however, any reference to normal rib plexus pressure, except an article I wrote with the collaboration of Henry Milch.³ In that communication we discussed first rib anomalies, the theories concerning their formation, and the mechanics of rib pressure on the plexus; we cited the few recorded cases of brachial nerve pressure by an *abnormal* first rib (two of which were operated on †), and we abstracted some reported cases of resection of a *normal* first rib for the cure of brachial pressure neuritis ‡.

It is my purpose now to report some cases in which pain in the arm was relieved by carrying the shoulder in an elevated position (for the purpose of taking off the drag of the plexus over the rib), to describe a case in which I resected a normal first thoracic rib for presumed brachial plexus pressure, and to discuss the technic of that operation.

Edwin Bramwell,¹ the Edinburgh neurologist, was the first to suggest (1903) a pressure relationship between the first rib and the first dorsal nerve root, entering the plexus, as an explanation of symptoms such as we now recognize as occurring with cervical rib, and which Buzzard had described in some of the cases he reported under the title "uniradicular palsies of the brachial plexus."⁴ And Thomas Murphy,²⁰ of Australia, appears to have been the first to resect a normal first dorsal rib for the relief of this condition. The symptoms disappeared promptly after the operation.

Three years later, Morley,⁹ in England, reported the case of a woman of forty-two with wasting of the hand muscles and long-standing pain in the distribution of the lower cord of the plexus, which was aggravated by carrying weights and relieved by elevating

* Read before the New York Surgical Society, February 23, 1927.

† In the previous paper a case operated on by Thorburn is classed as one of thoracic rib pressure because so cited by other authors and because Thorburn said the bone resected "closely resembles an imperfect first dorsal rib." It was described by him as a cervical rib, however, and the roentgenogram showed it to be such. Morley's case we grouped, by error, with the abnormal instead of the normal rib cases.

‡ I have found no addition to the literature since the above article was published except the brief report by Henry and Handousa,⁷ in Cairo, of a case of flaccid paralysis of the upper extremity appearing suddenly, with fever, and followed by the gradual development of gangrene of the second, third and fourth fingers, without sensory loss. When the palsied arm hung, subluxated at the shoulder, the radial pulse disappeared, when it was lifted the pulse returned. The reporters attributed the gangrene to compression of the subclavian artery at the thoracic inlet.

the arm in a sling or on the arm of a chair. Upon resecting a normal first rib the pains disappeared.

In 1920, Wheeler¹⁴ resected a normal rib in a man of thirty-five for the relief of coldness and wasting of the hand, and weakness involving the median and radial as well as the ulnar nerves. He had only slightly altered sensation in the fourth and fifth fingers, no pain, except at the outset, and decided increase of the gripping power of the hand when it was raised over the head. The result of the operation is not stated.

In 1919, Stopford,¹² of Manchester, recorded that he had encountered within two years ten cases of brachial nerve pressure by a normal rib. Nine of these were operated on (by Telford, Hey, Douglas), and seven are reported in detail.

Bramwell and Dykes² reported in 1921 that Sir Harold Stiles had operated upon "several" cases of brachial pressure by a normal rib, with very satisfactory results. Only a few of these are detailed. Stiles himself has not published these cases, but he has described the technic of the operation.¹¹

As some of these authors observed, the cases were of the type that often are, and several of them had been, dubbed "neuritis," "neuralgia," "progressive muscular atrophy," etc. A few of them were traumatic in origin, *i e*, the symptoms developed after an injury (*e g*, fracture of the clavicle) that caused sagging of the shoulder. In most cases the symptoms developed spontaneously, sometimes during adolescence, but they were often initiated or aggravated by exertion or dragging down on the arm by carrying heavy objects or wearing a heavy coat, and relieved by elevating the arm. In some patients the condition was worse in winter than in warm weather. No preponderance of either arm or either sex is to be gathered from the reports.

Sometimes the earliest symptom was pain along the ulnar border of the forearm. In most of the cases described in detail, the symptoms, as in most of the recorded cases of cervical rib, were chiefly in the distribution of the lower trunk of the brachial plexus (eighth cervical and first dorsal roots), *viz*, pain or sensory disturbances along the inner aspect of the arm and forearm and in the fourth and fifth fingers (medial brachial cutaneous, medial antibrachial cutaneous, and ulnar nerves) and atrophy of the hand muscles (probably chiefly ulnar nerve). In some cases there was also involvement of the median and radial nerve sensory areas. Common symptoms were coldness of the hand (sometimes associated with slight dusiness), weakness of the hand, and pain in the arm. Trophic sores are reported in two of Stopford's cases. Where the objective sensory disturbances are described, the loss of protopathic sensibility was greater than the epicritic loss. Stopford, who particularly called attention to this, had suggested that the dissociation is characteristic of nerve compression.

It is of interest, and importance, to note that in one of Stopford's cases and in one reported by Bramwell and Dyke, there was a cervical rib on the affected side (in one case on both sides), but at operation the pressure was found to be by the normal first rib, which was accordingly resected, and not by the supernumerary rib, which was therefore not molested. In both instances there was immediate relief of symptoms.

It would appear that in the above cases of normal rib resection the procedure was promptly followed by relief or, more often, by disappearance of the

sensory and vascular (vasomotor) symptoms. In many the pain and, if present, the cyanosis of the hand vanished at once. Some of the cases, however, were reported within a few months after operation, and there is no published record of any late results. I have a letter from Professor Stopford, dated December 22, 1926, in which he gives the following report on the ten cases he published in 1919:

CASE 1—I have never seen this patient again, as he was a soldier and was transferred to another command. Although he made an excellent recovery after the operation, I understand from the letter received three months after he left my charge, that he began to suffer from some pain again and also vascular or vasomotor symptoms. I believe this trouble persisted for at least a year, but the condition was never so bad as before the operation.

CASE 2—This patient made a very good recovery and there was no relapse. About eighteen months after operation, the only difference in the two hands was some weakness on the affected side in cold weather.

CASE 3—Made an almost complete recovery up to the time I last saw him, some six or eight months after operation. Indirectly I heard that he had a recurrence of some trophic disturbance, but I have no absolute confirmation, as the patient lived a considerable distance away and did not answer my letters.

CASE 4—Perfect recovery with no recurrence of symptoms except some tenosynovitis recorded in the paper.

CASE 5—Seen two years after operation and able to carry out her duties as a nurse.

CASE 6—No further record.

CASE 7—Perfect recovery and no recurrence some two or three years after. [This case was post-traumatic (gunshot fracture of the clavicle, with depression of the shoulder) treated by muscle education and faradism, not by operation.]

With regard to the three other patients treated in an earlier stage, as far as I have been able to ascertain the recovery has been complete and perfect and there has never been any complication since operation.

Thus of ten cases of brachial plexus pressure by a normal first rib (nine operated on), two are believed to have had some recurrence of symptoms, one could not be followed, and the other seven are cured.

AUTHOR'S CASES

1 Gertrude W., an apparently healthy married woman of fifty-two, was referred to me February 26, 1926, by Dr F. P. Keyes, of Brooklyn, because of pain in the right arm, which she had had most of the time since 1917. This pain was chiefly in the outer aspect of the arm and sometimes radiated to the hand or the neck. *She volunteered the information that she liked to rest her elbow on the arm of a chair because it gave relief.* There was never any limitation of motion, but sometimes the pain was so severe that the patient could scarcely raise her arm. She had been treated for "neuritis" without benefit. No roentgenographic examination had been made.

Both upper extremities appeared quite normal. There was no atrophy, œdema, or discoloration, and there were no sensory, motor or reflex changes.

Above the inner end of the right clavicle the pulsation of the first portion of the subclavian artery was plainly visible. Applying the stethoscope to it very lightly there was heard a loud bruit, *which disappeared when the arm was raised.* Neither the pulsation nor the bruit were of the proportions that would suggest an aneurism, however, and no aneurism was seen in roentgenograms. On the left side the pulsation of the subclavian was not to be seen and the sound, by stethoscope, was of normal pitch and volume.

The radial pulses were equal, whether the arms were raised or dependent. The blood-pressure was 165/100 in both arms.

No mass was felt in the neck. There was no tenderness or apparent deformity or stiffness in the regions of the cervical and dorsal vertebrae. Applying the finger-tips lightly on each side of the neck, about where the plexus crosses the rib, elicited pronounced tenderness on the right side but none on the left, and somewhat greater pressure caused pain to shoot down the right arm, but not the left.

The heart, aorta and lungs, by physical and roentgenographic examination were negative, the Wassermann reaction and the urine were also negative.

There was no drooping of either shoulder, and no history was elicited of any injury or illness that would account for the onset of the symptoms at the age of forty-five.

The X-ray films of neck, chest, shoulder were quite negative. In the absence of a cervical rib, pressure by a normal first dorsal rib was diagnosed. It was suggested that the patient consider the advisability of resection of the rib, and meanwhile she was instructed to carry her right shoulder raised, as much of the time as possible, by means of a snug ribbon sling passing under the flexed elbow, and to learn to keep the shoulder "hunched." This she did for several weeks and with so much relief that she was unwilling to submit to more definitive surgical treatment.

On November 22, 1926, she reported that from March to June the pain had been much less, in June it was again severe for several weeks, and again was relieved by wearing the ribbon sling, since then there had always been some, but never severe, pain—worse toward evening and soon after arising, but relieved by elevating the shoulder with sling, chair arm or her own muscles. Examination on that date showed no change in the physical signs.

2 Howard S., a rather slender man of thirty-nine, was referred to me by Dr. Eli Moschowitz, January 8, 1925. In 1921, he had had *right* subdeltoid bursitis, with subbursal lime deposits, which had caused pain and disability for several months but gave no symptoms after the summer of 1922. In September, 1924, he began to suffer with numbness and some pain in the fingers and arm on the *left* side. Roentgenograms then showed a small subbursal deposit on that side and, with the diagnosis of subdeltoid bursitis, he was treated by diathermy and baking with little relief. He said that in October, the tips of the fourth and fifth fingers were almost anaesthetic, that this improved and then had somewhat relapsed, and that he had a tingling sensation in the left hypothenar region. He complained also of moderate pain, chiefly along the inner aspect of the arm and forearm. All arm motions were free and painless.

Examination showed sloping shoulders and rather flabby muscles, no physical signs of subdeltoid bursitis, no loss of tactile or thermal sense in arm, forearm, hand or fingers, no atrophies, no disturbance of reflexes, no difference in the two radial pulses whether the arms were elevated or pendent, no mass in the neck, but pain in the arm when moderate pressure was made on the left brachial plexus. Roentgenograms showed no cervical or abnormal rib.

A ribbon sling, applied to keep the left shoulder elevated, gave great relief. On January 14th the patient reported himself distinctly better, and on the 21st still better. Exercises were then begun—hunching the shoulders, swinging Indian clubs, etc.—to develop the trapezius. On February 25th the patient reported that he had very little disturbance. On April 20th he wrote that he had been free of all symptoms for several weeks, was delighted with the results of the treatment, and was continuing his exercises.

3 Arthur S., aged sixty-two, came to me July 22, 1926, because for three weeks he had had aching pain in the right side of the neck (about the third vertebral level), the upper right scapular region, the outer side of the right arm and along the inner border of the forearm and hand to the level of the fifth metacarpo-phalangeal joint. The pain disappeared when in bed or otherwise recumbent, when the arm was raised (immediate

... as the arm was raised when he sat down. There was no limitation of or for the arm. The patient had been noticed to have a lesion of the arm and been well.

The patient had no other symptoms and symptoms. There was a tender area on the right side of the neck, cervical vertebrae. Some of the symptoms were in the right arm but none in the left. The right upper extremity was affected. No other symptoms. No disturbance of sleep or alteration of reflexes. The tendons were firm and equal in all portions of the arm. The pulsation of the subclavian artery was heard much more distinctly with the stethoscope on the right side than on the left—but that, I think, is of little significance. The urine was negative. The blood examination yielded in mgms p 100 cc: non protein nitrogen, 45; urea nitrogen, 24.3; uric acid, 43; creatinine, 17; sugar, 137; negative Wassermann reaction.

Röntgenograms showed a rudimentary cervical rib on the unaffected (left) side, and what was interpreted as an anomalous condition of the articulation on both sides of the sixth and seventh cervical vertebrae.

A ribbon sling was applied to keep the shoulder elevated. In the course of three weeks the pain subsided very much. When the sling was worn the arm was quite comfortable. The pain in the neck continued but that in the upper scapular region had ceased. Golf did not aggravate the condition. By September there were only occasional slight pains, which disappeared if the arm was raised. In December, the patient reported that he had only slight pain occasionally in the neck and shoulder, none in the arm or wrist.

Mrs. W., aged forty-five, a tall vigorous and athletic woman, an ardent pianist, wife of a New York surgeon, was referred to me February 23, 1927, by Dr. Morris Manges, of New York, because of pain in the right upper extremity. Twelve years ago, during her second pregnancy, she vomited a great deal and lost much weight. Two months before term she developed rather acutely pain in the inner aspect of the right forearm and the fourth finger, extending from elbow to finger-tip. This pain was severe and continuous until soon after childbirth. Two months thereafter she developed pain in the right shoulder, chiefly in the scapular region, and sometimes in the outer aspect of the arm. This lasted all that summer then disappeared, and the patient was entirely well for about three years. Then again during the period of an entire summer, she had numbness in the right hand and fingers on awakening, which often passed off on rubbing, but sometimes returned during the day as tingling and burning. There were then no pains. Since then, at irregular intervals she has had pain in the right scapular region and burning pain along the inner aspect of the right forearm and fourth and fifth fingers.

Early in the autumn of 1926, while playing piano rather strenuously, she frequently noticed slight swelling of the fingers of the right hand lasting for several minutes. There has never been cyanosis or sweating of the hand. For the past two weeks she has had burning and tingling along the inner aspect of the right forearm and the fourth and fifth fingers and sometimes the hand has felt cold. For these two weeks or more also, she has had pain in the right shoulder, as before.

The patient has no pain during the night and does appear to be relieved by recumbency. She has also noticed that the tingling and burning is more severe when the arm is raised and that the grip in her right hand is weaker when the arm is lifted above the head than when it is dependent. The patient does not believe that

BRACHIAL PLEXUS PRESSURE BY NORMAL FIRST RIB

carrying any weights in the right hand causes a sensation of weakness in that arm and she avoids doing so. Wearing a fur coat causes this sensation of weakness in the right shoulder. She has noticed, too, that when her arm hangs she gets numbness in the forearm and in the fourth and fifth fingers. Active piano and tennis playing aggravate and sometimes appear to initiate her symptoms. She has never noticed any atrophies or loss of sensation. She has had no limitation of movement in her shoulder or pain on motion.

She was left-handed as a child but learned to write with her right hand. She cuts with her left hand. She has had no injury to her shoulder but had a fracture of her right arm and forearm in childhood, and a traumatic synovitis of her right elbow nine months ago. She says that her symptoms are aggravated when she eats sweets and



FIG 1 —Mrs M C Röntgenogram showing upper ribs

pastries, but she has no hyperglycæmia or glycosuria. She has known that her right arm is a little longer than her left.

Aside from the fact that the right upper extremity is three-quarters of an inch longer than the left and that the patient has a double mitral murmur, physical examination of the chest, neck and upper extremities is in all respects negative. Röntgenograms of the upper thorax, neck and shoulders are also negative.

Her symptoms are typically those of pressure irritation of the lower cord of the brachial plexus.

5 Mrs M C, aged twenty-two, born in the United States, a teacher of acrobatic dancing, was referred to me April 21, 1926, by Dr F S Mason, of New York, because of very severe pain in the entire right upper extremity, coldness, slight duskeness and sweating of that hand, and slight œdema of the extremity, felt and seen most in the fingers.

The condition had its beginning, rather abruptly, at the age of fifteen, and continued unabated and with great suffering for two years. The pain during that period was

severe, and the extremity was sensitive to the touch—so much so that for several nights the patient let the arm hang rather than bear contact with the bed. During these two years also the hand was swollen much of the time and often cold and blue. In the second year, for several weeks, she could not raise the arm, she said, nor feel pin-pricks nor distinguish hot and cold. She was seen by several physicians in Providence, R. I., but none, she said, had made a diagnosis (except neuritis) and no treatment gave any relief.

At the age of seventeen the symptoms disappeared spontaneously. In a few months they recurred, and had continued with varying severity and for periods of varying

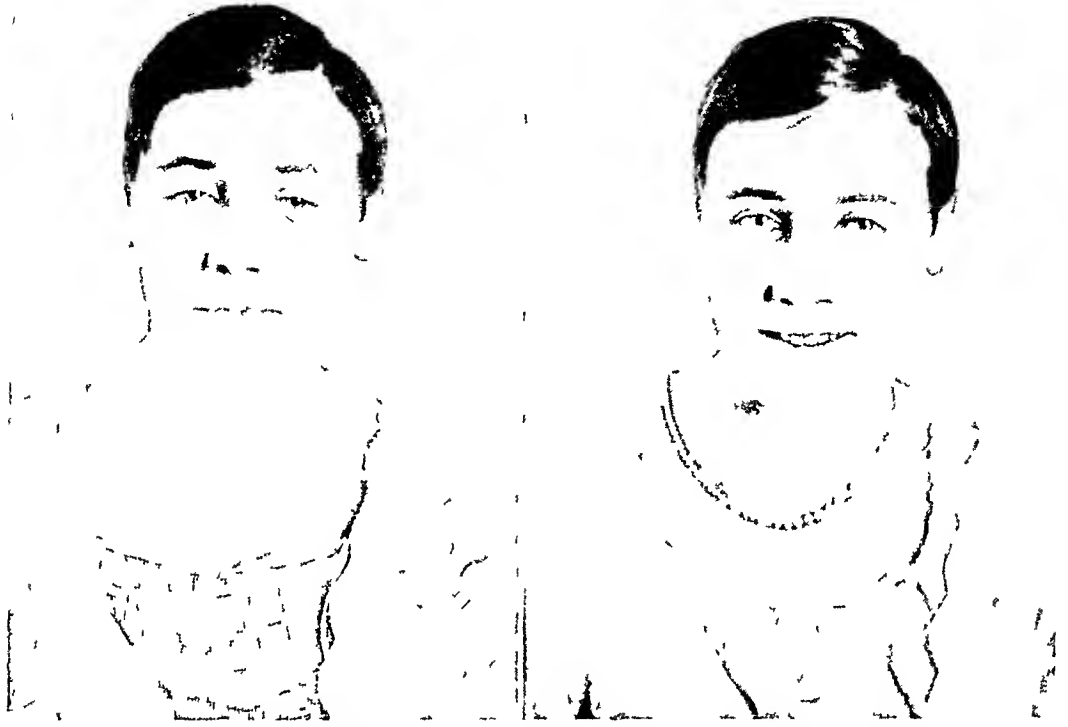


FIG. 2—Mrs. M. C. Photographs six days after resecting the first thoracic rib showing the incision used and its concealment by a necklace. The photograph on the left appears to show slight drooping of the eyelid on the left (unaffected) side. There was however no ptosis or Horner's syndrome on either side.

length. The free period was usually not long, but once had been about six months. At the time that the patient came to me she had been suffering for several weeks.

Her previous history suggested no illness or injury as a cause of this distressing condition, aside from which she enjoyed good health and good spirits, and there were no symptoms (or physical signs) suggesting disturbance of any of the viscera, including the ductless glands. The patient had five sisters and three brothers, none of whom had had any similar condition or any nervous affection, nor had her parents or their parents, brothers or sisters, as far as she knew. The left upper extremity was never affected. The pain in the right was sometimes present without any œdema, but there was never œdema without the pain. The latter might be at any part of the extremity but its maximum was in the fourth finger. Raising the arm gave only very transitory relief.

The patient was in apparent good health. Her general examination, and that of the urine and the blood, including the Wassermann reaction, were negative. There was nothing in her appearance, behavior or physical signs to suggest hysteria, even remotely.

The right hand was sufficiently œdematous to obliterate the normal cutaneous folds and to prevent the patient from fully extending or fully flexing the fingers. œdema in the forearm and arm, scarcely noticeable on inspection, was manifest on picking up the skin. The hand was cold, sweating and slightly cyanotic, whereas the left hand was

BRACHIAL PLEXUS PRESSURE BY NORMAL FIRST RIB

warm, dry and of normal color and skin texture. The entire upper extremity was very hyperæsthetic, especially the hand. There was no atrophy or muscle weakness, or material change in the tendon reflexes. Aside from the hyperæsthesia there was no sensory alteration, protopathic or epicritic. There was no limitation in any movements of the extremity other than that in the fingers due to the swelling.

The neck and shoulders were normal on inspection. No cervical rib or other mass was palpable. Gentle pressure with finger-tips or stethoscope where the right brachial plexus crossed the rib caused pain to radiate down the arm and into the upper thoracic region. Pressure on the left side caused no pain radiation. In certain positions of the head a bruit or high-pitched singing noise could be heard when the stethoscope was



FIG. 3—Mrs. M. C. Röntgenogram six days after operation to show the amount of rib resected.

pressed down over the first portion of the right subclavian artery, but not over the left, that, however, is a normal phenomenon, I believe.

The radial pulses were full, equal and unaffected by raising the arms. The blood-pressure was the same in both arms. Circumferential measurements showed only the slight difference that would be accounted for by the œdema. The right upper extremity is, however, one inch longer than the left, measuring from spine to finger-tip—a lengthening proportionately distributed through arm, forearm and hand. The patient and her dressmakers had also noticed this difference. The lower extremities are of equal length, they have never exhibited any disturbance.

Röntgenograms of the neck, right shoulder and upper chest showed no rib or other abnormality (Fig. 1).

This patient did not exhibit the characteristic symptoms of compression of the lower trunk of the brachial plexus—weakness and atrophy of the hand, anæsthesia or hyperæsthesia in the fourth and fifth fingers, pain and other sensory disturbances along the inner border of the forearm. Nevertheless, weighing all the data in her case and

considering the symptoms in some of the reported cases of rib compression (to which I shall revert), it seemed to me that hers, which appeared to be chiefly vasomotor, might well be caused by a cervical rib and, since she had no such supernumerary rib, might be due to pressure by her obviously normal first rib. Accordingly I advised its resection, to which the patient readily consented.

At the time of the *operation* which was done under ether narcosis April 30, 1926, at the Hospital for Joint Diseases, the patient still had great pain in her arm and the hand was quite œdematous, cold, sweating and slightly dusky. Lying somewhat on her left side and with the head turned to the left, a simple curved collar incision about 11 to 12 cm long was made on the base of the neck, sweeping from near the right sterno-



FIG. 4—Mrs. M. C. Röntgenogram eight months after operation. The rib is not regenerated.

mastoideus insertion backward and outward to the trapezius, so planned that it would cross the plexus yet lie not too far out to be concealed by a necklace (Fig. 2). Retracting the cut edges of the skin, the platysma and the middle branch of the supraclavicular nerve were divided. The external jugular vein was divided, between ligatures, near its termination. The posterior belly of the omohyoideus, separated from its fascial attachment, was drawn downward and forward with the sternomastoideus. The layer of fat next exposed and lying immediately upon the emerging brachial plexus, was dissected up as a single sheet. The transversa scapulae vessels were resected between ligatures as they crossed the plexus. The transversa colli vessels, which in this patient ran through the plexus, were likewise divided on each side of it. The scalenus anticus was identified, with the phrenic nerve crossing it and passing down between the subclavian artery and vein. The broad attachment to the first rib of the scalenus medius behind the plexus was identified, with the roots of the long thoracic nerve in and upon the hinder portion of the muscle.

The second and third portions of the subclavian artery ran downward in a straight line at an angle of about 65° with the clavicle from a point that appeared to be rather high in the neck. The vessel showed no constriction or dilatation. A thin prolongation of fascia running down along the artery was dissected off. The subclavian vein lying behind the clavicle, appeared to present no abnormal feature. The attachments of the two scaleni to the first rib were readily exposed by retracting the plexus and the subclavian artery alternately backward and forward. No actual pressure on the medial cord of the plexus was demonstrated.

Intermitting the retraction on the plexus at short intervals, the scalenus medius was divided close to its insertion in the rib, cutting through all but a posterior portion, which was left uncut to avoid both undue retraction of the muscle into the neck and damage to the posterior thoracic nerve. Hugging the first rib close with a sharply curved elevator, it was separated from Sibson's fascia beneath. Nibbling through with a rongeur the rib was divided posteriorly about 2 cm. from the tip of the transverse process of the vertebra. The anterior portion of the rib was found to drop at once nearly a centimetre. Again with rongeur, it was divided in front at the scalene tubercle. Thus there was removed from beneath the plexus and artery a segment of the first rib 4 to 5 cm. in its outer circumference. The cut edges of the rib were smoothed with the rongeur. The uninjured pleura was exposed at the bottom of the wound with what I took to be the first dorsal root and the first intercostal nerve lying upon it.

In order to relieve any possible pressure on the vessels by the scalenus anticus, this muscle was divided from without inward through three-quarters of its thickness and about 1.5 cm. above the rib, leaving an undivided internal portion to prevent undue retraction of the muscle mass. In doing this care was taken that the phrenic nerve was not injured and that the posterior fibrous portion of the muscle, lying against the subclavian artery, was divided. The cut surface of the scalenus medius was brought down and sutured to the undivided portion of that muscle, which considerably lessened the large size of the dead space. Although the operation was practically bloodless throughout and there was exceedingly little oozing in the depth, a small rubber dam drain was inserted to the pleura. The fat was sutured back in place over the plexus. The platysma was reunited with chromicized catgut. The skin wound was closed with a subcuticular suture. A compressive gauze dressing was held with adhesive plaster straps. The patient's condition at the end of the operation was excellent.

The next morning the torturing pain and the œdema had already completely vanished, and the extremity was no longer sensitive to the touch. Quite cold and clammy before the operation, the hand was warm and dry and the patient could flex and extend her fingers fully for the first time in many weeks. There was some numbness in the thumb and index finger, and pain in the deltoid region, both due to traction on the plexus. They lasted several days.

The drain was removed in forty-eight hours, there was no discharge whatever. On the third day the patient was out of bed. On the sixth day, after removal of the subcuticular suture, she walked to the photographic and X-ray departments of the hospital—where the pictures showing, respectively, the line of the incision and the amount of rib removed (Fig. 3) were then made. On the eighth day she left the hospital, apparently cured, and with no disabilities from her operation other than anæsthesia in the distribution of the middle supraclavicular nerve and a scar on the neck that can be concealed by an appropriate necklace.

For several months she was free from all symptoms. Then, in October, when she resumed her dancing lessons—which included "cartwheels" and manual stretching of her pupils' thighs—there was a gradual return of the old pains and soon thereafter, of the œdema, coldness and sweating of the hand. Added to these there developed a good deal of pain in the neck, extending sometimes behind the ear sometimes into the

posterior aspect of the shoulder. A roentgenogram in December, 1926, showed no regeneration of the divided rib (Fig 4). Now she is free from symptoms two months.

Stopford has written to me: "I have seen from time to time recurrences of trouble after the operation. The pain which recurs, in my experience, differs from that seen before operation, and I have often wondered whether the cause might not be one or more of the following: (a) insufficient amount of rib removed, (b) compression by callus or adhesion, (c) intraneural fibrosis, which I believe is quite common if rib compression has persisted for some time before operation."

"In some cases where there has been profound wasting of the small muscles of the hand, I have seen the pain relieved and the objective sensory disturbance reduced or removed by operation, but there has been little or no improvement in the muscles. This has led me to think that when atrophy of the small muscles has persisted for a considerable time or is very profound, prognosis as regards muscular power is bad. Whether this is due to intra-neural changes or to a profound atrophy of the small muscles, I am not prepared to say."

It is, of course, possible that in my case the relapse of symptoms was due to too early return to manual activity. It is also possible, however, that the condition is an obscure vasomotor disturbance (concerning which no neurologist whom I have consulted has enlightened me), that it was not due to rib pressure, and that the dramatic disappearance of symptoms after the operation was a remission initiated in some way by manipulation of the plexus or the artery.

I have seen a quite similar case at the Hospital for Joint Diseases.

6. This was in a school girl of sixteen, born in Russia. For two weeks, beginning abruptly and without known cause, she had had severe pain in the right arm extending from neck to fingers, œdema of the forearm and hand, and some cyanosis of the hand. Full extension of the fingers was prevented by the œdema, both active and passive abduction of the arm were inhibited by the severe pain. There was exquisite tenderness in the neck on slight pressure over the right brachial plexus, which also caused pain to shoot down the arm. No bruit or abnormal pulsation was noted in the neck. The right deltoid region was exquisitely hypersensitive. There were no atrophies and no objective sensory disturbances. The brachial nerves were very tender in the arm. The pulses were equal. The extremities were of equal length. There was no droop of either shoulder. Roentgenograms were negative. The symptoms subsided in a few weeks. I have not been able to learn whether there has been any return.

In the absence of localizing sensory and motor medial cord compression symptoms in my operated case, the presumption of rib pressure seemed to me nevertheless justified by various considerations. Not all the reported cases of rib pressure relieved by operation had this lower trunk syndrome, and some of the cases had symptoms quite similar to mine. Thus, in Murphy's case (resection of a normal first rib) the symptoms had existed for eight years. There were "pain, numbness, coldness, tenderness and loss of power in the left shoulder, forearm and hand, with swelling and dusky blue discoloration

of wrist and hand worse after any exertion such as tennis playing or typewriting severe in winter months and comparatively mild in summer The arm, forearm and hand tender and painful on pressure throughout their whole extent There was no localization to any particular nerve The hand and forearm were cold The patient could not close her hand There was some impairment of sensation in the hand and some wasting of the forearm " On pressure over the plexus there was felt a tender point of resistance and pain shot down the arm

In Hvorslef's⁵ case (abnormal first rib in a male) there was steady pain in the left elbow radiating to the hand, which at times became cold and pale, and tingling in the fingers No root distribution appears to have been made out

In Hauswirth's⁶ case, in which a fibrous band was found extending from the end of a cervical rib to the first rib, the patient, a girl of seventeen had pain in the left shoulder, arm and forearm from pressure of any kind above the clavicle, pain on manipulation of the shoulder and, later, swelling, cyanosis and coldness of the hand and forearm and stiffness of the fingers

All three of the above cases were promptly rid of their symptoms after resection of the rib, but, also, all three were reported within a few months of the operation

Buzzard⁷ said "Results of observations had convinced him that pain of almost any description and any distribution within the upper extremity could be associated with the presence of cervical ribs" He doubted whether there was anything about the sensory symptoms which were quite characteristic and he referred to two cases of cervical rib in which vasomotor symptoms were the prominent features One of them had been operated on, with excellent results

Bramwell and Dykes, discussing pressure by the first thoracic rib, mentioned that coldness of the hand is very common "No objective sensory disturbance may be detected, although very usually some sensory loss, which corresponds more or less to root distribution, is met with, tactile sensibility being less affected than painful and thermal sensibility" They describe five types of rib pressure, symptomatically One of these is of "rare cases in which vasomotor disturbance is the striking morbid manifestation" The vasomotor symptoms, according to Todd,¹ are probably due to pressure on the sympathetic fibres in the first dorsal root ¶

THE TECHNIC OF RESECTION OF THE FIRST RIB FOR BRACHIAL PLEXUS PRESSURE

The steps of the operation are related in my case report There are, however, certain details that need discussion

The Incision—Stiles, Telford,¹² and Wheeler, who described their proce-

¶ Pupillary signs are not to be expected since these sympathetic fibres are given off before the nerves reach the rib In the few recorded cases of cervical rib with pupillary changes the supernumerary rib is presumed to have been only incidental to a syringomyelia

dures, approached the rib by raising a triangular skin flap, fashioned by a transverse incision parallel to the clavicle and a longitudinal incision along the edge of the trapezius (Stiles, Wheeler), along the posterior border of the sternomastoideus (Telford). Such an incision would leave a scar disfiguring on a woman, but I do not doubt that it is necessary in dealing with a fat or muscular neck. For other subjects, however, I found on the cadaver and in my reported case that the incision here described and illustrated gives an adequate exposure. The first rib can also be reached from behind, as one does in thoracotomy for tuberculosis, by a longitudinal incision through the trapezius. This also would leave a scar that a woman cannot well cover, it would cause more or less drop-shoulder by division of the trapezius and, most important, it would not give a free exposure of the plexus and the subclavian artery, which one would want to inspect.

Hæmostasis—The external jugular vein, the transversa scapulæ and the transversa colli are the only vessels beneath the platysma that require ligation, and if care is taken in separating and cutting the rib there should be little or no bleeding in the depth.

Retraction of the plexus should be as gentle as possible and should be intermitted very frequently.

The Periosteum—A right-angled curved elevator is convenient for freeing the rib from its deep muscle attachments. Wheeler frankly states that he removed the rib subperiosteally. Stiles' and Telford's descriptions are not very clear on this point. In my case I tried to remove the inferior leaf of the periosteum with the rib. Unfortunately, the specimen was lost before I could examine it, so I am not sure that I did this. Theoretically, at least, it is better to remove the periosteum with the rib, lest the lower cord of the plexus, now lying on this periosteum, should become compromised by regenerating bone. Actually, however, this is probably not likely to happen. Subperiosteal resection is technically easier and it avoids the chance of injuring the first intercostal artery and the pleura. The pleura is, however, fairly well protected by Sibson's fascia, and even if it is torn a little, Stiles says that no harm results.

Dividing the rib is done with bone forceps by Telford, with bone forceps anteriorly and with Shoemaker's rib shears posteriorly, by Stiles. The first rib is rather broad and lies flat over the apex of the lung. I found, therefore, both on the cadaver and in my patient, that costotomes and bone-cutting forceps are awkward. The rib is easily divided, however, by biting through with a narrow-beaked angular rongeur. This has only the inconsequential disadvantage that it somewhat reduces the size of the bone resected, as a specimen.

The Scaleni—Stiles cuts only the scalenus medius. Telford partially cuts also the scalenus anticus to increase the exposure of the rib, I cut it to relieve any possible pressure on the subclavian artery. The cut muscle retracts very much, greatly increasing the dead space created by removal of the rib.

Telford does not seem to make any effort to close this space. Stiles reduces it by suturing the retracted scalenus medius to the uppermost digitation of the serratus magnus. I found myself unable to do this both on the cadaver and on my living subject. I materially reduced the space, however, by drawing down the retracted portion of the muscle and stitching it to the undivided portion. In dividing the scaleni one must avoid the phrenic nerve on the anticus, and the long thoracic nerve on the medius.

Drainage—In spite of the depth and the size of the dead space, if the wound is dry a drain is unnecessary. Neither Stiles nor Telford employs it, they depend upon the gauze dressing to obliterate the space.

SUMMARY

There are cases of pain in the arm with paræsthesias and other phenomena, that are relieved by elevating the shoulder and by exercising the trapezius to keep it elevated. These cases, of which three are reported, are probably due to dragging of the brachial plexus over the first rib.

There are more severe cases in which all the phenomena of pressure by a cervical rib are produced by the pressure of an abnormal or even a normal first thoracic rib. Several have been cured by resection of the first rib. The technic of the operation is described.

When operating upon a case of cervical rib, it is important to observe whether the pressure to be relieved is due to this supernumerary, or to the normal first, rib.

Two cases are reported of intermittent severe pain and œdema in one upper extremity, occurring in adolescent females and perhaps due to plexus pressure by the first rib.

REFERENCES

- ¹ Bramwell, Edwin. Lesion of the First Dorsal Nerve Root. *Rev. Neurol. and Psychiat.*, 1903, vol. 1, p. 299.
- ² Bramwell, E., and Dukes, H. B. Rib Pressure and the Brachial Plexus. *Edinb. M. J.*, Aug., 1921, vol. xxvii, p. 65.
- ³ Brickner, Walter M., and Milch, Henry. First Dorsal Simulating Cervical Rib—by Maldevelopment or by Pressure Symptoms. *Surg., Gynec. and Obst.*, Jan., 1925, vol. xl, p. 38.
- ⁴ Buzzard, E. Farquhar. Unrathicular Palsies of the Brachial Plexus. *Brain*, 1902, vol. xxv, p. 299.
- ⁵ Buzzard, E. Farquhar. *Proc. Roy. Soc. Med.*, vol. vi-1, Clin. Sect., p. 139.
- ⁶ Hauswirth, Louis. Cervical Rib, Report of a Case. *Amer. J. Surg.*, Dec., 1905, vol. xix, p. 147.
- ⁷ Henry, A. K., and Handousa, A. Gangrene of Fingers Due to Subclavian Compression. *Brit. M. J.*, Aug. 7, 1926, p. 254.
- ⁸ Hosleif, Jakob. Abnormal First Dorsal Rib Simulating Cervical Rib. *J. Minn. State Med. Assn. and Northwestern Lancet*, June 1, 1911, vol. xxxi, p. 251.
- ⁹ Morley, John. Brachial Pressure Neuritis Due to a Normal First Thoracic Rib. Its Diagnosis and Treatment by Excision of Rib. *Clin. Jour.*, Oct. 22, 1913, vol. xlii, p. 461.

- ¹⁰ Murphy, Thomas Brachial Neuritis Caused by Pressure of First Rib Austral M J, Oct 20, 1910, vol xv, p 582
- ¹¹ Stiles, Sir Harold Contributed to Jones and Lovett's Orthopedic Surgery, Wm Wood & Co, New York, 1923, pp 549-551
- ¹² Stopford, John S B, and Telford, E D Compression of the Lower Trunk of the Brachial Plexus by a First Dorsal Rib With a Note on the Surgical Treatment Brit J Surg, 1919, vol vii, p 168
- ¹³ Todd, T Wingate The Descent of the Shoulder after Birth Anat Anz, 1912, vol xli, May 18, p 257, June 15, p 385
- ¹⁴ Wheeler, Sir W I de C Compression Neuritis Due to the Normal First Dorsal Rib Practitioner, 1920, vol civ, p 409

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- ¹⁰ Murphy, Thomas Brachial Neuritis Caused by Pressure of First Rib Austral M J ,
Oct 20, 1910, vol xv, p 582
- ¹¹ Stiles, Sir Harold Contributed to Jones and Lovett's Orthopedic Surgery, Wm Wood
& Co , New York, 1923, pp 549-551
- ¹² Stopford, John S B , and Telford, E D Compression of the Lower Trunk of the
Brachial Plexus by a First Dorsal Rib With a Note on the Surgical Treatment
Brit J Surg , 1919, vol vii, p 168
- ¹³ Todd, T Wingate The Descent of the Shoulder after Birth Anat Anz , 1912, vol
xli, May 18, p 257, June 15, p 385
- ¹⁴ Wheeler, Sir W I de C Compression Neuritis Due to the Normal First Dorsal Rib
Practitioner, 1920, vol civ, p 409

PRIMARY ULCER OF THE JEJUNUM*

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THAT primary ulcer of the jejunum is a rare lesion is evident from the fact that up to 1921 none had been observed at the Mayo Clinic. A patient suffering from such a lesion came under our care in September, 1925.

The patient, S K (History Nos N S 6606-7218), was first admitted to the University Hospital in August, 1925, with a chief complaint of pain in the epigastrium, belching, vomiting and loss of weight.

He had been troubled for six months with constipation and dull upper abdominal pain, with gaseous cructations and vomiting. The pain would occur about two hours after eating, was in the epigastrium and right upper quadrant and radiated across the upper abdomen to the left, occasionally to the back, but never downward. The taking of food did not relieve him, in fact it made him so much worse that he reduced his diet to such an extent as to cause a loss of thirty-seven pounds in weight. Sodium bicarbonate gave some temporary relief, but this was usually due to the vomiting which it induced. He had never had any hæmatemesis or jaundice.

His past medical history was negative.

The physical examination was negative except for slight tenderness in the right lower abdomen. There was no abdominal rigidity, no distention and no masses were palpable.

The tentative diagnosis was duodenal ulcer.

The laboratory findings were as follows: Blood count: Rcd blood-cells, 5,000,000, hæmoglobin, 100 per cent, white blood-cells, 9700, polymorphonuclears, 62 per cent, lymphocytes, 30 per cent, large mononuclears, 5 per cent, transitionals, 3 per cent. Urine: Negative. Wassermann: Negative. Gastric analysis:

	Free	Total
FC	12	34
1	34	52
2	42	66
3	36	64
4	52	94
5	56	88
6	48	66
Rcs	16	38

X-ray (G I): Stomach negative. Duodenum uncertain. Colon: Ptois of right side, considerable stasis. No tenderness over a visualized appendix.

Operation, September 3, 1925. Appendectomy. Operator, Dr G P Muller. Right rectus incision. The stomach and duodenum and gall-bladder were carefully examined for evidences of disease, but none were found. The duodenum was in a somewhat high position, but was otherwise negative. The appendix was felt bound down in the right iliac fossa. The upper abdominal wound was closed.

A McBurney incision was then made and a chronically diseased appendix was removed through this incision. There were numerous peri-appendiceal adhesions.

* Read before the Philadelphia Academy of Surgery, February 7, 1927.

After operation the patient vomited daily. The vomitus was bile-stained. He was discharged from the hospital on September 19, 1925, with instructions to report back to the follow-up clinic in one month.

He did not return until November 15, 1925. Since discharge he had become progressively worse. The X-ray examination at this time showed a high jejunal obstruction. The abdomen was scaphoid, the peristalsis was about normal and no masses were palpable. There was some tenderness in the mid-abdomen.

The plasma CO₂ was 100 volumes per cent, but after giving him ammonium chloride by bowel, this was reduced to 78 volume per cent. He was given enteroclysis of tap water and saline hypodermoclysis for twenty-four hours before operation, which was performed by Doctor Muller on December 1, 1925.

Operation—Resection of jejunum, gastro-enterostomy—posterior method. Dr G. P. Muller. Left rectus incision. When the peritoneal cavity was opened, a small contracted bowel presented itself. This was followed upward toward the jejunum. About twelve inches from the duodenojejunal flexure a loop of dilated small bowel was encountered. On bringing this up into the wound the site of obstruction was easily seen. This consisted of an annular, sclerosing mass encircling the jejunum, while in the surrounding mesentery were numerous large lymph-nodes.

It was felt that the mass was either a sarcoma or a carcinoma. Resection appeared imperative so that this was done and the bowel brought together by end-to-end anastomosis. A posterior gastro-enterostomy was then done, the loop used being distal to the anastomosis.

The patient stood the operation quite well and was returned to the ward in good condition.

For two days his convalescence was uneventful, but on the evening of December 3, he began to vomit. A Jutte tube was introduced into the stomach for drainage. The abdomen became soft, the gastric distention was relieved and the patient improved considerably for twenty-four hours. The following day we gave him glucose and insulin intravenously. On December 7 his condition became worse, he began to vomit large amounts of bile-stained fluid, the pulse rose rapidly and his appearance was that of a high intestinal obstruction.

Under gas-local anesthesia I opened the abdomen with a high left rectus incision. The stomach was opened along the greater curvature and the gastro-enterostomy opening was found. There was a great deal of bile-stained fluid in the stomach which was aspirated.

One rubber tube was placed in the efferent and one in the afferent loop of the jejunum. One tube was also placed through the pylorus into the duodenum.

The major portion of the opening in the stomach was then closed and the small gastrostomy opening was allowed to remain. This was brought up into the wound and fixed to the rectus sheath. The tubes were sutured to the wall of the stomach.

He improved temporarily, but on December 9 developed circulatory incompetency with cyanosis and dyspnea, and died.

The pathological report on the specimen removed was: Gross examination. Specimen consists of part of the jejunum, which is the seat of a rather large, irregularly outlined ulcer. The lymph-glands in this region of the jejunum were extremely large and pressing against the wall so as to produce a bulging within the lumen of the gut.

Microscopic examination. Sections of the gland show chronic inflammatory tissue. Sections from the ulcer margin show chronic inflammatory tissue.

Diagnosis. Chronic lymphadenitis and chronic jejunal ulcer.

Etiology—As yet no one has offered a satisfactory explanation of the etiology of peptic ulcer in general. Focal infection has been given consider-

able place in the factors to be considered, but why this should account for the almost universal occurrence of ulcer in the pyloric antrum and the first portion of the duodenum needs further elucidation. That that portion of the intestine which extends from the papilla of Vater to the aggregated lymph nodules of the intestine is singularly free from ulceration can be seen when I have been able to find only twenty-four cases of primary jejunal ulcer in the literature. The ulceration of the ileum which occurs in the various specific infections is the result of the invasion of the aggregate lymph nodules. The solitary lymph patches of the jejunum are not so prone to invasion in these diseases. Moreover, chronic ulcer rarely results after acute ulceration of the lymph follicles in the specific infections. Whatever the initial cause of the necrosis in the usual ulcer of the duodenum and stomach the acid gastric juice, although not the exciting cause, is surely a very definite contributory factor in maintaining its chronicity. In fact, it is probable that it is the deciding factor which explains the preponderance of chronic ulcers occurring above the entrance of the pancreatic ducts. Can this acidity be a factor in the primary jejunal ulcers?

The acid of the contents of the stomach is neutralized after passage into the duodenum. McClendon in estimating the pH of the lower part of the human duodenum found that this varied from 4.5 to 5.1 and in the ileum from 5.9 to 6.5. However, there is no hydrochloric acid present in the jejunum and the slightly observed acidity must be due to weakly dissociated acids. On the other hand, although hydrochloric acid has been neutralized and pepsin inactivated by the time that the chyme has reached the jejunum, proteolytic digestion takes place through the action of trypsin.

Yosaishmodaira believes that the jejunal ulcers are the result of an intense vaso-paralysis with local necrosis due to stasis and disturbed nutrition.

Whatever the cause of the local necrosis, tryptic digestion can act similarly to peptic digestion in preventing the repair of the ulcer by cicatrization.

It has been supposed by some that jejunal ulcer may occur after diseases that destroy the efficiency of the pyloric portion of the stomach or that interfere with the normal character of the gastric or duodenal secretion. Suffice it to say that with three agencies present in the intestinal tract to neutralize any excess acid, each of which possesses sufficient alkali to neutralize the hydrochloric acid of the gastric juice, it is highly improbable that peptic digestion as such plays any part in the occurrence of jejunal ulceration. In the jejunal or marginal ulcers which follow gastro-jejunostomy the acid gastric juice is undoubtedly a factor, but these secondary ulcers do not come within the scope of this paper.

Richardson recently, and Frankel earlier, have suggested the probability of syphilis as the cause of this lesion. It is well known that syphilis affects the jejunum more often than any other part of the small intestine. The tendency to form an ulcerated ring around the bowel and the frequency of perforation have suggested this etiology. Weiss found perforation seven times

in a series of thirty-four cases of intestinal syphilis. On the contrary, however, syphilitic ulcers are usually multiple and in the cases reported most of the ulcers have been single. Since the use of the Wassermann reaction or its modifications only one of the reported cases has had a positive reaction for syphilis.

Pathology—These ulcers probably begin as acute ulcers and pass on to the chronic stage. The ulcers reported have as a rule been rounded and clear cut with punched-out edges. The mucosa is much more affected than the deeper tissues. In cross-section they have a terraced structure. This accounts for the fact that in the cases with perforation the serosal opening has been extremely small. In the jejunal ulcers there is apt to be considerable inflammatory reaction, so that enlarged mesenteric nodes, the result of chronic lymphadenitis, are fairly common.

In one of Richardson's cases and in three others in the literature besides our own, the ulcer caused an annular constriction. As a rule it affects a limited portion of the ante-mesenteric border of the jejunum. Since there is a marked chronicity in many of the operated cases, it is not unlikely that jejunal ulceration may be the forerunner of jejunal carcinoma.

Symptomatology—I have found it exceedingly difficult to form a composite clinical picture of this condition from reported cases. Many of these have no clinical history in the reports and others are entirely inadequate. In those in which a complete history is given, the symptoms vary so widely that a definite clinical history of the composite type is difficult. The lesion occurs with greater frequency in the male, the ratio being about 7 to 2. The age varies from seventeen to fifty-seven, although the majority of the cases occur between the ages of thirty and fifty.

In many of the cases the history is similar to that seen in gastric or duodenal ulcer. A history of "stomach trouble" or "indigestion" lasting for a period of months or years is present in many of the reported cases. In other cases the symptoms were of exceedingly short duration, while in some perforation apparently was the first sign of an intra-abdominal lesion.

Pain, often associated with the ingestion of food, has been a predominant symptom. It is true that the onset of this pain is delayed for a period often much longer than that seen in the usual peptic ulcer. The ingestion of food has in some instances relieved the pain while in others, as in our case, this relief did not occur. It would appear from perusal of the reported cases that those patients obtaining relief after the taking of food had ulcers very close to the duodenal-jejunal flexure. The pain in many of the cases was in the mid-abdomen just above the umbilicus.

Very few of the reported cases sought relief until obstructive symptoms or perforation took place. In operating for obstruction or perforation of the alimentary tract, the jejuno-ileum must be considered as a possible site for the pathology. In the cases operated on for chronic ulcer of the stomach and duodenum and where no ulcer is found after careful inspection,

PRIMARY ULCER OF THE JEJUNUM

it would be advisable to inspect the upper jejunum. In several of the cases reported gastro-jejunostomy was performed in order to relieve the "dyspepsia" which was supposedly due to duodenal ulcer. In these cases the ulcer was distal to the jejunal loop which was used for the anastomosis, and it was some time later that the intestinal ulcer was found to be the real cause of the patient's trouble. Although vomiting is a frequent symptom in those cases having obstructive symptoms, hæmatemesis has never been noted.

In the perforated cases the location of the pain is at first in the mid-abdomen, but rapidly becomes generalized. The board-like rigidity which rapidly appears is like that seen in perforated peptic ulcer.

In the chronic cases the only possibility of diagnosis would appear to depend upon jejunal stenosis as demonstrated by the X-ray.

Treatment—When the diagnosis is made there is no alternative to surgical treatment. Unlike peptic ulcer there is no so-called medical treatment. In those cases where an annular growth with enlarged mesenteric glands is found, the question of malignancy must be kept in mind. Such a case we have recently had and it so closely resembled the case I am reporting that it was not until the pathological report was obtained that we knew the difference in the two. Since so many of the reported cases have gone on to perforation, resection of the jejunum will offer the best opportunity of future well being.

CASES IN THE LITERATURE

Since the data of many of the reported cases is so meagre, I am giving the name of the author and a very few notes on each case.

- 1 Sestier, 1829, perforation, death
- 2 Wagner, 1858, male, eighteen, trauma to abdominal wall, perforation and death, no operation
- 3 Perroud, 1867, male, thirty-two, perforation and death, no operation
- 4 Reverdin, 1867, male, fifty-five, perforation and death, no operation
- 5 Parenski, 1876, male, forty-five, perforation and death
- 6 Rufz, 1843, male, thirty-six, perforation and death, no operation
- 7 Simpson, 1897, male, fifty-six, perforation and death, no operation
- 8 Taylor, 1865, male, forty-five, trauma, perforation, death
- 9 Brigidi, 1893, perforation of ulcers of jejunum and ileum, no operation, death
- 10 Dodson, 1906, male, fifty-seven, trauma to groin, perforation and death, no operation
- 11 Jankowski, 1908, male, forty-eight, perforation and death, no operation
- 12 Hugh Lett, 1909, female, fifty-four, small perforation of chronic ulcer, suture, recovery
- 13 Bryan, 1916, male, forty-eight, perforation, operation, death
- 14 Murphy, 1916, male, sixty-two, operated for duodenal ulcer, but also found jejunal ulcer
- 15 Richardson, 1922, male, forty-seven, perforation, excision of ulcer, recovery
- 16 Richardson, 1922, female, forty-eight, perforation, enterectomy, recovery
- 17 Cade, 1913, male, twenty-five, perforation, death
- 18 Walton, 1922, female, forty-five, enterectomy, recovery
- 19 Schoo, two cases found at autopsy
- 20 Rotgans, 1909, found one in patient operated on for gastric ulcer

- 21 Schmilinski, 1910, female, sixty-three, chronic stenosing ulcer, enterectomy, recovery
- 22 Letulle, 1895, male, eighteen, perforation and death
- 23 Kretschmer, 1920, male, thirty-nine, resection

BIBLIOGRAPHY

- Van Roogen Arch f klin Chir, 1909, vol xci, p 381
Combes Les ulcers simple de l'intestin These de doct, Toulouse, 1897
Leotta Arch ital di chir, 1919-1920, vol i, p 349
Wagner Arch f Physiol Heilkunde, 1858, vol ii, p 280
Taylor Guy's Hospital Reports, 1865, vol xi, p 282
Reverdin Bull et mem Soc anat de Par, 1867, vol xii, p 597
Simpson Practitioner, Lond, 1897 vol lvii, p 165
Schmilinski Muenchen Med Wochenschr, 1910, vol lvii, p 1616
Cade *et al* Progres med, 1913, vol xxiv, p 309
Murphy Surg Clin Chi, 1916, vol v, p 431
Bryan Surg, Gynec and Obst, 1916, vol xxii, p 279
Herzog Zeitr z path Anat u z allg Path, 1912-1913, vol iv, p 177
Sestier Bull et mem Soc Anat de Par, 1827, vol iii, p 33
Meyer Deutsch Ztschr f Chir, 1905, vol lxxvi, p 297
Cruice Am J Med Sc, Phila, 1911, vol cxlii, p 683
Lazerevic Deutsch Med Wchnschr, 1919, vol xlv, p 1923
Obendorfer Arch f path Anat, etc, Berl, 1900, vol clx, p 179
Weiss Zentralbl f d Grenzgeb d Med u Chir, 1902, vol v, p 577
Fraenckel Arch f path Anat, etc, Berl, 1910, p 131
Arkin Jr Chicago Path Soc, 1909-1912, vol viii, p 224
MacCallum Text-book of Path 1916, p 656
Richardson Surg, Gynec and Obst, 1922, vol xxv, p 1
Dodson Brit Med Jour, 1906, vol i, p 718
Walton Brit Jour Surg, 1922, vol x, p 152
LeBasser These, Paris, 1921
Letulle Presse Med, 1895, p 135
Gandy These, Paris, 1898-1899
Kretschmer Deut Med Woch, 1920, vol xlv, p 69

OBSERVATIONS ON PEPTIC ULCER* (*Continued*)

IV PATCH TRANSPLANTS OF JEJUNUM IN THE STOMACH†

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THIS study was made in order to determine the effect of surgical duodenal drainage on the mucosa of patches of jejunum of whole thickness transplanted into the wall of the stomach. Patches of jejunum with intact circulation were substituted for several different portions of the gastric wall. The fate of these patches was studied for long periods both before and after surgical duodenal drainage, an operation known to produce ulcer of the duodenum and jejunum.

Takats and Mann have reviewed the work of previous workers in this field and studied numbers of jejunal patch transplants in the stomachs of dogs and found them quite satisfactory. In their experiments they found very few ulcers and those only on patches situated on the lesser curvature of the stomach near the pylorus.

In a previous paper I reviewed some of the many procedures that have been devised to produce ulcers in the gastro-intestinal tracts of experimental animals. Acute lesions have been induced by many investigators but few have been able to produce chronic types of ulcer. Probably the most successful procedure was described by Mann and Williamson, who devised an operation for surgical duodenal drainage which induced typical chronic peptic ulcers in dogs in more than 90 per cent of experiments. These ulcers were produced in the duodenum and jejunum and were grossly and microscopically almost indistinguishable from peptic ulcers encountered clinically. I also reported the production of peptic ulcers in the stomachs of dogs. In my experiments peptic ulcers of the jejunum occurred in almost 100 per cent of cases following surgical duodenal drainage, and when areas of gastric mucosa were excised following the operation for surgical duodenal drainage, healing of the denuded areas was always delayed. The delay in healing was most marked in denuded areas on the lesser curvature and in more than 50 per cent of these experiments typical chronic peptic ulcers developed in denuded areas on the lesser curvature. In other previous papers I reported work done on various other phases of experimental production of chronic peptic ulcers.

Method of Experimentation—Because surgical duodenal drainage retarded the healing process in the stomach and frequently induced ulceration in denuded areas on the lesser curvature, I performed a series of

* See ANNALS OF SURGERY, February, 1927, vol lxxv, p 207

† Submitted for publication, February 7, 1927

experiments to determine how surgical duodenal drainage would affect patches of jejunum transplanted into various portions of the wall of the stomach. All experiments were performed on normal, healthy dogs and for all operative procedures either anaesthesia and aseptic technic were employed. No rubber-covered or other intestinal clamps and no unabsorbable sutures were used in any of the operations.

All animals were used first for control experiments. A patch of jejunum was transplanted into various portions of the wall of the stomach, the lesser curvature, greater curvature, anterior wall and posterior wall. Patches were

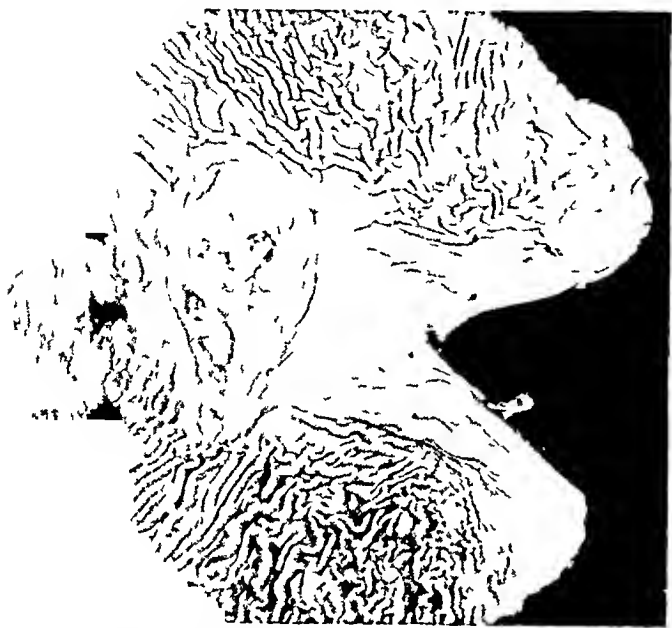


FIG. 1.—Photograph of stomach showing typical peptic ulcer in jejunum following surgical duodenal drainage and typical peptic ulcer in patch in lesser curvature.

obtained by resecting a loop of jejunum about 5 cm in length with its mesenteric circulation carefully preserved. The loop of jejunum was then split longitudinally opposite its mesenteric attachment and trimmed to an approximately circular shape about 5 cm in diameter designed to replace a resected area of gastric wall of similar size and shape. The patch was sutured into place with its own mesenteric circulation intact and the continuity of

the intestine was reestablished by end-to-end anastomosis. Following this operation animals were kept for long periods. They received the usual care and regular diet of normal dogs. All of them remained in excellent condition.

At various intervals after the first operation the condition of the patch of jejunum was carefully observed at laparotomy. Frequently at the same laparotomy the operation for surgical duodenal drainage into the ileum was performed as described by Mann and Williamson and repeated by me.

Following this operation animals were carefully observed for evidence of ulcer. Milk and syrup were added to their diet for the maintenance of normal nutrition. Most of the dogs remained in good condition until the ulcer (which developed at the usual site in the jejunum) became a definitely chronic lesion. From large series of experiments with surgical duodenal drainage it has been found that the dog's nutrition, except for an initial decrease in weight immediately after operation, does not decline appreciably until the ulcer in the jejunum has progressed to a considerable degree of chronicity. Final observations on the condition of the jejunum and of the stomach with its patch of jejunum were made at necropsy.

OBSERVATIONS ON PEPTIC ULCER

Results—There were twenty-one experiments in which patches of jejunum of whole thickness were transplanted into the wall of the stomach. In thirteen of these experiments the patch was inserted in the lesser curvature of the stomach near the pylorus. In the remaining eight experiments the patch was placed in various other regions of the stomach. Patches were observed at various intervals from thirty-six to four hundred and nineteen days following their transplantation.

In only one case was an ulcer found in any of the twenty-one patches. This was an ulcer 1.5 by 0.7 cm. found at necropsy one hundred and sixty-three days after the patch had been transplanted. The patch in which this ulcer was found had been placed on the lesser curvature near the pylorus (Table I).

TABLE I
Series of Jejunal Patches

Dog	Patch placed in stomach date of operation	Situation of patch in stomach	Patch explored date of operation	Condition of patch	Time interval, days
1	1-30-25	Lesser curvature near pylorus	3-25-26	Normal	419
2	7- 9-25	Lesser curvature near pylorus	2- 1-26	Normal	175
3	7-27-25	Lesser curvature near pylorus	2- 1-26	Normal	157
4	7-27-25	Lesser curvature near pylorus	2- 1-26	Normal	157
5	7-28-26	Lesser curvature near pylorus	1- 7-26	Ulcer on patch, 1.5 by 1 cm	163
6	7-28-26	Lesser curvature near pylorus	9- 2-26	Normal	36
7	7-29-25	Lesser curvature near pylorus	2- 4-26	Normal	190
8	8- 7-25	Lesser curvature near pylorus	2- 4-26	Normal	181
9	9- 7-25	Lesser curvature near pylorus	1-20-26	Normal	135
10	9- 7-25	Lesser curvature near pylorus	1-22-26	Normal	137
11	9- 7-25	Lesser curvature near pylorus	1-25-26	Normal	140
12	9- 9-25	Lesser curvature near pylorus	1-25-26	Normal	138
13	9- 9-25	Lesser curvature near pylorus	1-20-26	Normal	133
14	3- 9-26	Anterior wall near pylorus	6- 7-26	Normal	90
15	3-10-26	Anterior wall near pylorus	6- 7-26	Normal	89
16	3-10-26	Middle of anterior wall	6- 7-26	Normal	89
17	3-11-26	Middle of posterior wall	6-10-26	Normal	91
18	3-18-26	Middle of posterior wall	6-10-26	Normal	84
19	3-23-26	Middle of greater curvature	7- 1-26	Normal	100
20	3-23-26	Anterior fundus region	6-11-26	Normal	80
21	3-23-26	Anterior fundus region	6-11-26	Normal	80

In thirteen experiments surgical duodenal drainage was instituted after transplanted patches of jejunum had been normal for from eighty to four hundred and nineteen days. In five of these experiments the patches had been inserted in the lesser curvature near the pylorus. In three of this number typical chronic ulcers were found in the patches at necropsy seventy-seven, thirty, and thirty-nine days, respectively, following surgical duodenal drainage (Fig 1). In the remaining eight experiments in which the patches had been placed in various other sites in the stomach (Fig 2) only one ulcer was found following surgical duodenal drainage. This was not a chronic ulcer but was merely a small superficial erosion found in a patch in the anterior wall (Table II).

TABLE II
Series of Jejunal Patches After Duodenal Drainage

Dog	Jejunal patch		Duodenal drainage date of operation 1926	Date of necropsy 1926	Condition of patch	Time interval, days	Ulcer in jejunum
	Situation in stomach	Duration days					
1	Lesser curvature near pylorus	419	3-25	6-22	Normal	89	None
2	Lesser curvature near pylorus	175	2-1	4-19	Ulcer 2 by 1.5 cm	77	None
3	Lesser curvature near pylorus	157	2-1	3-3	Ulcer 2 by 1.5 cm	30	1 by 1 cm
4	Lesser curvature near pylorus	157	2-1	3-12	Two ulcers, one perforated	39	2 by 1 cm
5	Lesser curvature near pylorus	190	2-4	3-5	Normal	29	1.5 by 1.5 cm
6	Anterior wall near pylorus	90	6-7	7-5	Normal	28	None
7	Anterior wall near pylorus	89	6-7	7-30	Normal	47	Perforating ulcer, 1 cm
8	Middle of anterior wall	89	6-7	7-5	Normal	28	Perforating ulcer, 3 by 2 cm
9	Middle of posterior wall	91	6-10	7-30	Normal	50	1 by 1.5 cm
10	Middle of posterior wall	84	6-10	7-30	Normal	50	3 by 3 mm
11	Middle of greater curvature	100	7-1	7-30	Normal	29	8 by 8 mm
12	Anterior fundus region	80	6-11	6-18	Normal	7	None
13	Anterior fundus region	80	6-11	6-29	Superficial erosion	18	2.5 by 2 cm

Discussion—These experiments show that there is a definite tendency toward the formation of peptic ulcer on the lesser curvature of the stomach. Patches of jejunum transplanted into various portions of the wall of the stomach, and thus subjected to an unfavorable acid environment, when observed for long periods remained normal except in one case. In this case

a chronic peptic ulcer developed in a patch in the lesser curvature of the stomach. Patches which had remained normal for long periods in spite of the unfavorable acid environment in the stomach were then subjected to conditions produced by surgical duodenal drainage. Except for a superficial erosion in a patch implanted in the anterior wall of the stomach, ulcers developed only in patches in the lesser curvature of the stomach. Typical chronic ulcers developed in three of five patches in this situation.

The formation of ulcer in jejunal patches following duodenal drainage indicates that the environment of the jejunal transplants had been rendered

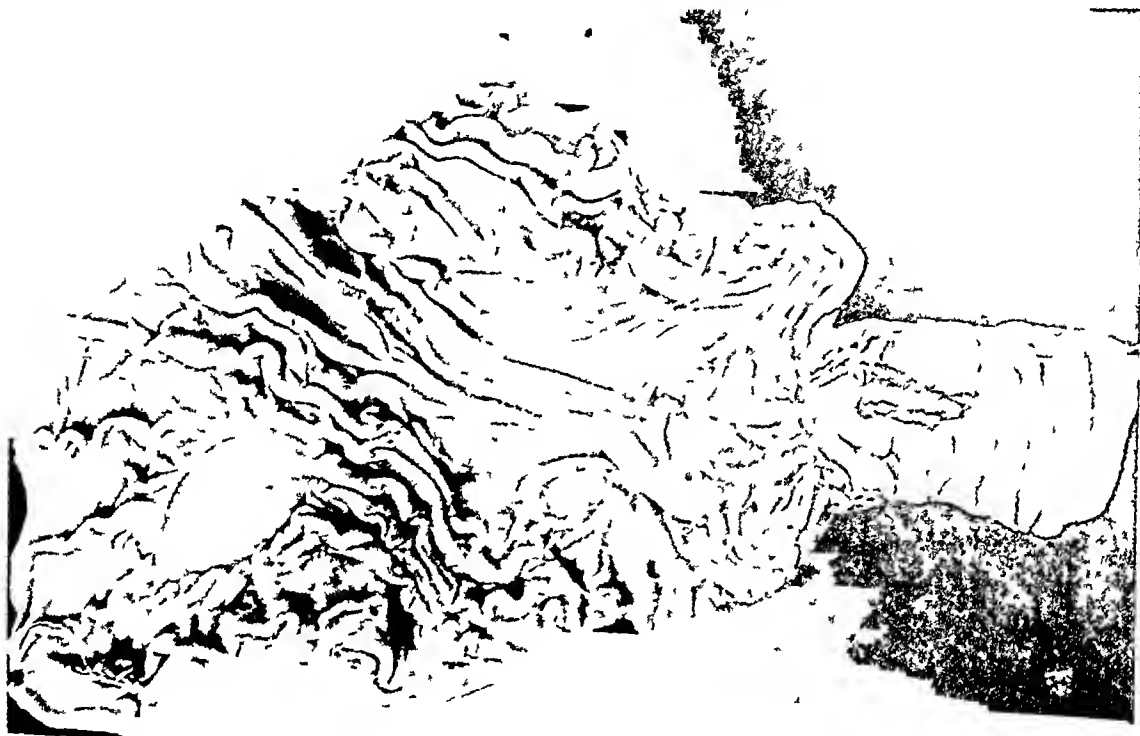


FIG. 2.—Photograph of stomach showing typical peptic ulcer in jejunum following surgical duodenal drainage and normal patch in anterior wall.

still more unfavorable, and may be fairly attributed to that disturbance of acid-alkali balance in the stomach which duodenal drainage might be expected to induce.

These findings are in accord with clinical statistics which show that a very high percentage of all ulcers of the stomach occur on the lesser curvature. They are also in accord with data of experiments previously reported by me in which I found that surgical duodenal drainage had a very marked effect on the process of healing in the stomach. Areas denuded of mucosa in various regions in the stomach healed readily under normal conditions, but when subjected to the acid-alkali imbalance in the stomach caused by surgical duodenal drainage showed marked delay in healing. Areas on the greater curvature healed completely while areas on the lesser curvature healed very sluggishly and went on to chronic peptic ulceration in as high as 62.5 per cent of prolonged experiments.

The lesser curvature is the "Magenstrasse," the gastric street, as

expressed by Aschoff and others. It bears the brunt of the mechanical trauma administered to the gastric mucosa in the process by which the forces of muscular contractions empty the stomach. The stomach impels ingested material most directly along the lesser curvature to expel it through the pylorus and the lines of force exerted by the contracting gastric musculature tend to converge along the lesser curvature.

The acid-alkali imbalance in the stomach resulting from surgical duodenal drainage and the relatively exposed position of the lesser curvature in relation to trauma in the emptying process in the stomach seem to be important factors in explaining the presence and site of the ulcers found in these experiments. The patch of jejunum transplanted into an environment to which it was not accustomed may well have served as a point of least resistance. The importance of these factors in cases of clinical peptic ulcer is suggested by the close parallel between clinical statistics and experimental data.

SUMMARY

Some of the previous work on autoplasmic transplantation of patches of jejunum into the walls of the stomach and on the experimental production of peptic ulcers has been reviewed.

Twenty-one experiments on dogs were described in which patches of jejunum with intact mesenteric circulation were transplanted into the wall of the stomach at various points and observed for periods as long as four hundred and nineteen days. All patches remained in normal condition except one. In this case a chronic peptic ulcer developed in a patch in the lesser curvature of the stomach.

Thirteen experiments were described in which patches that had remained normal for long periods up to four hundred and nineteen days were subjected to the acid-alkali imbalance in the stomach resulting from surgical duodenal drainage. Patches were in various regions of the stomach. Except for a superficial erosion which developed in a patch in the anterior wall of the stomach ulcers developed only in patches in the lesser curvature. Typical chronic ulcers developed in three of five patches in this situation.

The acid-alkali imbalance in the stomach and adjacent intestine resulting from surgical duodenal drainage and the relatively exposed position of the lesser curvature in relation to trauma in the emptying process in the stomach were suggested as important factors in explaining the presence and site of the ulcers found in the experiments. The possible relation of these factors to clinical problems was mentioned.

BIBLIOGRAPHY

- ¹ Mann, F. C. The Effect on the Jejunal Mucosa of Exposure to the Gastric Juice. *Jour Med Res*, 1917, vol. xxv, pp. 289-294.
- ² Mann, F. C. The Chemical and Mechanical Factors in Experimentally Produced Peptic Ulcer. *Surg Clin N Amer*, 1925, vol. v, pp. 753-775.

OBSERVATIONS ON PEPTIC ULCER

- ³ Mann, F C, and Williamson, C S The Experimental Production of Peptic Ulcer
ANNALS OF SURGERY, 1923, vol LVII, pp 409-422
- ⁴ Morton, C B Observations on Peptic Ulcer I A Method of Producing Chronic
Gastric Ulcer, a Consideration of Etiology ANNALS OF SURGERY, 1927, vol LVV
pp 207-221
- ⁵ Morton, C B Observations on Peptic Ulcer II A Rontgenologic Study of Experi-
mentally Produced Chronic Ulcers ANNALS OF SURGERY, 1927, vol LVV, pp
222-229
- ⁶ Morton, C B Observations on Peptic Ulcer III Healing of Experimental Peptic
Ulcer after Gastro-enterostomy ANNALS OF SURGERY, 1927, vol LVV, pp 229-238
- ⁷ Takats, Geza de, and Mann, F C The Effect on the Jejunal Mucosa of Transplants to
the Lesser Curvature of the Stomach ANNALS OF SURGERY, 1927 (In Press)

MESENTERIC CYSTS[†]

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CYSTS of the mesentery are interesting because of their history, rarity, origin and disputed classification, the infrequency of their being diagnosed and as a cause of intestinal obstruction

The first case, a female child, who had intestinal obstruction as a result of the cyst occluding the bowel, was an enterogenous cyst operated upon May 5, 1924. The second, an adult male, was operated upon by Dr Charles F Mitchell, March 26, 1925. This sac contained a sebaceous-like material and was thought to be a dermoid. Other cases have been reported by fellows of the Philadelphia Academy of Surgery. Dr H C Deaver,¹ Congenital mesenteric cysts, 1909. Dr Charles H Frazier,² Mesenteric cysts with a report of a case of sanguineous cyst of the mesentery of the small intestine, 1913. Dr Thomas A Shallow,³ Entero-mesenteric cysts, April, 1925. Dr William J Ryan,⁴ Omental cysts, October, 1926.

History—Their history has been divided by Braquehaye⁵ into three periods, and Ney and Wilkinson,⁶ in 1911, suggested a fourth.

First Period—The first case recorded was by Benevieni, a Florentine anatomist, in 1507. He found it accidentally at autopsy, and characterized it as an anatomical marvel. Tulpio, Morgagni and others, from that time until about 1850, reported cases, but in each instance, the tumor was discovered only at the post mortem.

Second Period—From 1850 to 1880, a few were treated by operation, but almost invariably upon a wrong diagnosis and with a uniformly fatal result.

Third Period—From 1880 to the present time. Many were reported in which a diagnosis was made before celiotomy and were then treated with good results chiefly by French surgeons, among whom Pean, Millard, Tillaux, and Merklen were especially worthy of mention.

Ney and Wilkinson, in 1911, suggested a *Fourth Period* from 1900 to the present time, commencing at the time of Dowd's⁷ interesting theory—"The origin of mesenteric cysts from embryonic sequestration," and extending to the present day.

Cysts of the mesentery are among the *surgical rarities*. In text-books, the subject is either omitted altogether or dismissed in a few brief sentences. However, Dowd states that reports indicate that mesenteric cysts are being removed at least as often as once a month and if microscopical examination of their walls and chemical and microscopical examinations of the contents are made, the entire subject should be soon understood. Cystic tumors of

* Read before the Philadelphia Academy of Surgery, February 7, 1927

MESENTERIC CYSTS

the mesentery are probably more uncommon than similar lesions of any of the other structures of the abdominal cavity

In 1886, Augagneur⁸ found that 18 out of 90 cases of tumors of the mesentery were cystic. Arckion,⁹ 1891, gave reference to 81 reported cases. In 1892, Braquehay (loc cit) added 23 to his number, making 104. In 1897, Moynihan¹⁰ reported nine additional cases and Dowd (loc cit) in 1900, collected from literature 32 cases. This makes a total of 145 cases. Dowd, however, stated that many of these are not reported sufficiently in detail to make them really intelligible.

Edward G. Jones¹¹ says that Lawson Tait is said never to have seen a mesenteric cyst and Spencer Wells only two. Dr. L. L. McArthur, of Chicago, stated in 1912 that he had never seen a chylous cyst of the mesentery and quotes the late A. H. Ferguson as having the same experience. In 1912, Friend,¹⁴ of Chicago, collected fifty-two cases of the chylous type and in 1913, A. L. Benedict,¹² of Buffalo, supplemented Friend's list, bringing the total to ninety-six. The chylous type embraces approximately one-half of the mesenteric cysts, so that about 200 in all can be found in medical literature.

F. Rosenblatt,¹⁴ in 1915, stated that about 200 isolated cases were recorded in literature. This excludes omental cysts which are usually classed under mesenteric cysts and are, no doubt, similar in structure and origin. Doctor Ryan states that there have been but forty-four cases of omental cysts reported since 1852, when Gairdner reported an autopsy specimen before the Pathological Society of London. Cysts may occur in the various parts of the mesentery. Dowd (February, 1921) stated that no case has occurred in the mesentery of the appendix, but one sees no reason why it should not occur there as well as in any other region of that structure and in all probability many have been found there. In reviewing the literature, I have found that in 1913, Willems, W.,¹⁵ reported a dermoid cyst between the layers of the mesoappendix.

Carter,¹⁶ in his article in 1921, says that there have been between two and three hundred cases reported including all varieties.

Higgins and Lloyd,¹⁷ in July, 1924, stated that about 250 cases have been published, chiefly by surgeons, since the first case described by the Florentine anatomist Benevieni, in 1507.

The *genesis* of mesenteric cysts was a very obscure subject until rather recent years. A considerable amount of speculation has been indulged in an attempt to explain the origin of the cystic tumors of the mesentery. The ideas of the older pathologists were indefinite. Such cysts were attributed variously to lymph stasis, with resultant dilatation of a lymphatic gland or vessel, and to cystic degeneration of a lipoma or tuberculous glands. Rokitansky¹⁸ in 1842, Moynihan in 1897, and Dowd in 1900 have each offered theories. Dowd's article aroused renewed interest in this subject, and recent work has resulted in a very considerable increase in our knowledge, though even now there is no general agreement of the writers.

We can determine the nature of a cystic tumor by studying the life history, its location, the structure of its wall and the character of its contents. Classifications have been based upon these findings.

The first formal description of such a cyst was made by Rokitansky in 1842. Subsequently, Brucy and Rokitansky each described a number of these cysts and each endeavored to prove their origin from degenerated lymph-nodes. To this, singularly enough, Virchow,¹⁹ 1887, agreed. In 1892, Braquehay (loc cit) classified mesenteric cysts as (a) sanguineous, (b) lymphatic cysts, including chylous cysts, (c) hydatid

cysts, (d) congenital and dermoids, (e) cysts of adjoining organs, ovaries, pancreas, etc In 1897, Moynihan (*loc cit*) classified them as (a) serous, (b) chylous, (c) hydatids, (d) blood, (e) dermoid, (f) cystic malignant disease

In 1900 appeared Dowd's widely quoted paper in which he divided mesenteric cysts according to what he believes to be their origin into (a) Embryonic, including—1 Dermoids, 2 Serous, 3 Chylous, 4 Hemorrhagic, 5 Cysts with walls like that of intestines, (b) Hydatid, (c) Malignant disease

He successfully removed from the transverse mesocolon of an adult woman a cyst which closely resembled in detail a multilocular ovarian cystoma The ovaries of this patient seemed normal on palpation In presenting this case, he pointed out the close anatomical relationship existing in embryonic life between the Wolffian body or germinal epithelium and the root of the mesentery, and suggested the possibility of the sequestration from the germinal epithelium of a group of cells which might be displaced by the subsequent growth of the individual in such a way as to take up an intramesenteric position, later on, perhaps, during the adult life, such a sequestrum from the germinal epithelium might develop into a tumor similar to the one he removed Going further, he suggests that small portions of the developing gut may be similarly sequestered to lie perhaps between the leaves of the mesentery and later develop into a cyst The emphasis laid on the probably embryonic origin of a large number of mesenteric cysts represented a decided advance in our knowledge of this subject Since Dowd's paper, this idea has been repeatedly emphasized and elaborated

In 1902, Moynihan (*loc cit*) also expressed the opinion that most of such cysts originate from embryonic remnants

In 1906, Ayers, J C,²⁰ expressed himself as of the same opinion but simplified Dowd's classification by adding two more groups, (a) cysts arising from the glandular structure of the intestinal wall, (b) cysts of the normally placed retro-peritoneal organs

In 1907, Niosi,²¹ in an excellent paper, states his belief that about one-half of all mesenteric cysts are acquired and places the so-called lymphatic and chylous cysts in this group Klemm,²² on the other hand, in 1905, found the wall of the lymphatic mesenteric cysts to be made up wholly of those cells which arise from the mesoderm, and argues that these cysts are neoplasms developing from misplaced or sequestered portions of the mesodermic tissue, and hence form a group of tumors of embryonic origin for which he proposes the name of "mesodermoids," by way of analogy to that group of tumors called dermoids

Niosi divided embryonic mesenteric cysts as follows

1 Cysts of intestinal origin, (a) Sequestrations from bowel during development, (b) From Meckel's diverticulum 2 Dermoids 3 Cysts from retroperitoneal organs (germinal epithelium, ovary, Wolffian body, Mullerian duct)

In 1909, Deaver, H C, agreed with Dowd that all such growths, with the exception of parasitic and malignant cysts, are of embryonic origin

Eric Gould, also in 1913, approved of Dowd's simplified classification, but because of several cases of chronic abscesses that he had seen in the mesentery of tuberculous nature, he suggested that the simplest and most correct pathological grouping is into the three classes as follows

1 Cysts arising in embryonic remnants and sequestered tissue, (a) Serous, (b) Chylous, (c) Sanguinous, (d) Dermoids, (e) Cysts from intestinal diverticula 2 Cysts of infective origin, (a) Hydatids, (b) Tuberculous abscesses 3 Malignant cysts

In 1913, Miller,²³ in a most complete article on "Enterogenous Mesenteric Cysts," states that the idea that a portion of an embryonic tissue or organ may become sequestered and still continue to develop though usually in an anomalous manner, is a familiar one Bauer²⁴ credits Verneuil and Remak with the first proposal of this idea, while quoting Ribberts' expression of the theory as the best A free rendering of this passage from Ribberts is perhaps not superfluous Epithelial cysts may be formed not only

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as a result of trauma, but also by abnormal development, irregular growth may cause a change of position or a changed relationship without actual change of position, or, again, epithelial structures which should coalesce fail to do so, or finally, those which should decrease in size, or disappear entirely retain their maximum dimensions. A group of epithelial cells with its connective-tissue support is rendered more or less independent in growth by either of these processes and thenceforth develops as a cyst whose lumen is constantly enlarged by the retention of its own secretion and desquamated epithelium, although this increase in size is usually extremely slow and scarcely noticeable. When suggesting this process to explain the enterogenous origin of certain mesenteric cysts, Dowd argues by analogy, instancing, the comparative frequency with which a typical development results in an accessory thyroid, spleen, or pancreas. The actual process of sequestration from the developing gut was not observed until 1908, when there appeared a report from Lewis and Thyng in which they described the "regular occurrence of intestinal diverticula in embryos of the pig, rabbit and man." Previous to this time, Lewis had discovered a "knoblike outpocketing of the intestinal epithelium a short distance beyond the pancreas" in a rabbit embryo, while Thyng had found a similar structure in a human embryo of 136 mm and had interpreted it as an accessory pancreas. Lewis and Thyng have thus established the fact that the formation of diverticula and cysts is a regular occurrence in the embryonic development of the gut. There can be scarcely a doubt that such a cyst may occasionally persist to be recognized after birth as a "mesenteric cyst."

While the findings of Lewis and Thyng account for a certain number of mesenteric cysts, there is a general agreement among those who have studied this question that most juxta-intestinal cysts, even when intramesenteric in position, have their origin in the vitelline or omphalo-mesenteric duct or in Meckel's diverticulum.

It is apparently established that Meckel's diverticulum or persistent remnants of the omphalo-mesenteric duct may give rise to a mesenteric or juxta-intestinal cyst along practically the entire course of the small bowel, though such an occurrence must be exceedingly rare in the extreme upper limits of the bowel.

Miller suggests certain general features which may aid one in determining whether a cyst represented the process of sequestration from the bowel as described by Lewis and Thyng, or whether it developed from Meckel's diverticulum or the persistent remains of the omphalo-mesenteric duct. Manifestly, the problem presents many difficulties and is wholly impossible.

A mesenteric cyst of either of these two types (Lewis and Thyng's embryonic cysts and the omphalo-mesenteric duct) arises from the bowel whose structure it shares, such a cyst, when typical and unaltered by inflammation, presents certain features which are quite characteristic and easily recognized. The resemblance to the adjacent bowel may be little short of exact, in that there is found a mucosa with typical glands, goblet cells and ciliated cells, well-developed villi, a distinct submucosa and two layers of smooth muscle placed at right angles to each other. The picture, however, is usually not so clear. The widest variations from the typical are found in the epithelial linings. The wall of a typical enterogenous cyst shows two well-developed layers of smooth muscle running at right angles to each other as they do in the bowel wall.

Arguments based on cellular structure must take into account the possibility of histological alterations in the wall of a cyst, for such changes could readily obscure the picture, inflammation can substitute scar tissue for any other tissue.

In 1915, Jones, E. G.,²¹ likewise agrees that there is a growing tendency to regard most mesenteric cysts as having their genesis in embryonic rests.

In 1921, R. M. Carter suggested another classification though evidently based on Dowd's as follows:

1. True mesenteric cysts, subdivided according to their probable origin into (a) Embryocystomata, (b) Enterocystomata, by which I understand not only tumors of

Meckel's diverticulum, but also tumors arising from sequestrations from the bowel,
(e) Obstructive possibly 2 Dermoids 3 Cystic malignant disease 4 Parasitic

By applying this classification to all cystic tumors of the mesentery, Carter believes that more uniformity of description would at least be obtained than at present exists in the literature

It is plain that more and more are coming to regard all mesenteric cysts not parasitic or malignant, as of embryonic origin. The term "cystic malignant disease" which has been given as a class of mesenteric cysts is no longer tenable. Malignant cysts are probably for the most part originally simple cysts which subsequently have become malignant. Moreover, a metastatic malignant tumor of the mesentery or, for that matter, a primary one which undergoes cystic degeneration is not morphologically a cyst.

Some anomalous and hitherto unclassified cysts are true mesenteric cysts which have developed from meso-dermal remnants behind the peritoneum but which, unlike the ordinary clinical mesenteric cyst, have not moved anteriorly into the developing peritoneal folds.

It is important to distinguish the cysts of which we speak from the large cysts of the kidney which occur generally singly and quite apart from chronic nephritic, congenital cystic disease, and echinococcus infection, these are cysts of the kidney substance proper and may communicate with the pelvis or contain fluid closely allied to urine, whereas the pararenal variety is definitely outside the kidney, and, though they may indent its substance, are not attached to it, and contain the characteristic fluid previously described. Pararenal cysts are very rare, and have received scant notice in the text-books. There is no mention of them in *Keen's Surgery* and only a few lines in some of the standard works on urology. Thus, Morris, Garceau, Thomson, Walker and Kidd all refer briefly to them, and allude to a possible origin from Wolffian body remnants, but no attempt seems to have been made to associate them particularly with mesenteric cysts, nor does their close resemblance and that of their contents, to mesenteric cysts seem to have received due notice.

Many writers speak of true mesenteric cysts as not being malignant, parasitic or dermoid.

Dowd, in speaking of "dermoid cysts," as well as many others, believes them always to be due to an error in development in the ovary or some one of the epithelial structures. They occur chiefly in the abdomen and in places where skin-covered surfaces coalesce during embryonic life. When in the abdomen they are believed to be of ovarian origin. There have been records of several mesenteric dermoids. Gould, in 1913, stated that about 23 dermoids had been reported in an article written in 1908. Since that time, we have found at least twelve others reported, making a total of thirty-five to the present time. Schultzer records one in which two canines, two incisors and eight molars were present. Mayer describes a dermoid larger than a man's head which was taken from the mesentery, it was free from the genitals. The inner cyst wall was smooth and shiny and beset with long black hair, the fluid was yellowish-brown similar to pea soup.

Spencer Wells removed from between the folds of the mesentery one which contained bundles of fine hair and six pounds of fatty material and flattened epithelium. Langton removed a dermoid from between the layers of the mesentery and another

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from each ovary König states that he has observed a dermoid cyst in the mesentery These cysts are all believed to be of embryonic origin and I know of no other theory which explains their formation

Ney and Wilkinson and others have noted that all mesenteric dermoids reported have occurred in females and, therefore, conclude that all are of ovarian origin Higgins and Lloyd (*loc cit*), 1924, also state that no retroperitoneal or mesenteric dermoids have been reported in the male, though they have occurred in the testis which is originally a retro-peritoneal organ This has been held as evidence that an ovary is responsible for the true dermoid when it occurs in the mesentery

Moynihan, 1897, says that cystic disease of the mesentery is very much more common in women than in men The only form of cyst found with perhaps equal frequency in the two sexes is the hemorrhagic cyst as one might suppose from the mode of origin Dermoid cysts have been found only in women The extremes of life are not exempt from the disease Cases are recorded at the age of four months (Lucasett and Winwarter) and at the advanced age of eighty years

In 1913, Willems, W., reported a case Dermoid cysti zwischen den Blättern der Mesoappendix

Symptomatology and Diagnosis—There are no signs or symptoms which are pathognomonic of mesenteric cysts but given a tumor in the abdominal cavity which is smooth, rounded and cystic and unusually mobile as in our first case, we should think that the diagnosis would be easy That the diagnosis of mesenteric cysts is difficult, is proved by the fact that no case has been recognized with certainty previous to operation or autopsy In a typical case, the mobility of the tumor is the striking feature Other symptoms are the result of pressure on the bowel with resultant pain and obstruction symptoms Porter says that pain is more frequent with this condition than with any other type of abdominal cystic tumor A history of repeated attacks of abdominal pain associated frequently with vomiting and often with alternating periods of diarrhoea and constipation is significant These attacks are presumably due to increased peristalsis, in an effort to overcome the narrowing of the bowel produced by the encroachment of the cyst upon its lumen or they may be due to attacks of partial volvulus This narrowing may occasionally be so great as to cause absolute obstruction, a volvulus may also become complete Strangulation and gangrene of the gut due to pressure have occurred

General wasting is not a characteristic symptom even when a large tumor is present and obstruction of the lacteals might be expected Small cysts may give rise to no symptoms whatever, unless, for some cause or other, an acute inflammatory condition arises Under such circumstances, the symptoms are similar to other acute abdominal conditions and must be differentiated As the cyst becomes larger, they must be differentiated, from ovarian cysts, retroperitoneal growths, hydronephrosis, movable kidney, pancreatic cysts, new growths of the intestine and the pregnant uterus

The differential diagnosis may be considered briefly under two heads as described by Higgins and Lloyd 1 Diagnosis from other intra-abdominal tumors 2 Diagnosis between individual cysts

In a typical case, the situation, mobility and general characters of the

tumor may localize it with probability to the mesentery, and serve to distinguish it from other abdominal swellings. Its cystic character may also be surmised. It should usually be possible to exclude parasitic and malignant cysts, but a tuberculous abscess in the mesentery may present all the features enumerated above, and indeed, in childhood at any rate, is the most common type of "mesenteric cyst" to be exposed by operation.

Though it is admittedly a very difficult diagnosis to make, yet, there are cases where, once suspected, a mesenteric cyst should be diagnosed. Obviously, the attempt ought always to be made.

Complications—1 Intestinal obstruction is the most frequent and the most serious of the common complications. In a small series of 17 enterogenous cysts, acute obstruction occurred in nearly 50 per cent, whilst the group mortality of 35 cases of obstruction due to this cause was 35 per cent. The methods by which it may be brought about are mechanical, and include volvulus, intussusception, kinking, adhesions, and narrowing or occlusion of the intestine over it.

2 Peritonitis, when it occurs, is a sequel to the above.

3 Hemorrhage into the cyst has caused death.

4 Rupture of the cyst may also cause death (Timbal²⁶), but there are two cases of recovery following what seems to have been spontaneous rupture of the cyst into the bowel.

5 Torsion of the cyst.

6 If a mesenteric cyst occupies the pelvis, it may itself become impacted or may give rise to symptoms varying with the organ upon which it presses.

The *treatment* of mesenteric cysts may be covered in a few words as described by Miller. In the group of acute cases we are dealing always with intestinal obstruction or peritonitis and the treatment is directed toward these conditions primarily and the operation is an emergency.

In the second group, the latent cases, the operation is an elective one and choice is to be made between—1 Drainage, 2 Enucleation, and 3 Resection. *Drainage* is attended by a very low primary mortality but is apt to result in a persistent sinus, which will ultimately require excision, and, hence, is not altogether desirable. Without differentiating the type of cyst dealt with, Coley²⁷ has estimated the mortality following drainage at 6 per cent. This probably includes some deaths due to complications and seems a very high rate.

Enucleation was done ten times without a death in 16 cases. This is undoubtedly the procedure of choice when it is feasible. The cyst may be part and parcel of the intestinal wall, when it is impossible to enucleate without opening the gut. Enucleation of a cyst or multiple cysts may do irreparable damage to the circulation of the bowel, enforcing resection. Dense adhesions may render enucleation impossible without tearing the bowel. The cyst may occupy an intra-intestinal position, as in several reported cases, near the ileo-cæcal valve and even be drawn into the cæcum, simulating an intussusception. In such circumstances, the bowel must be

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opened to expose the cyst. These conditions among others may compel resection.

In five cases of *resection* of Miller's series, there were three deaths, a mortality of 60 per cent. So high a mortality is due partly to the serious condition of most of these patients, but the figures serve in a general way the relative safety of enucleation of the cyst as compared to resection of the bowel.

Undoubtedly, the best treatment is *enucleation* when it can be done without seriously injuring the bowel.

Aspiration has no place in modern surgery, although it was the favorite procedure with the older surgeons.

Marsupialization is also obsolete, and properly so, unless in very exceptional instances.

CASE I—M. B., female child, age seven, private patient in the Germantown Hospital. Admitted April 25, 1924. Discharged cured May 5, 1924.

Eight days before admission to the hospital, the child began to have attacks of pain in the upper abdomen with vomiting. These pains became progressively worse, were paroxysmal and followed with vomiting. The day before admission, the vomiting increased in severity and was fecal. The bowels had not moved for three days and there was no flatus expelled during the last twelve hours. The mother stated that the child had several attacks somewhat similar in character and that constipation had existed for years. She also noticed that the child's abdomen was enlarged but thought the swelling disappeared as she recovered from the attacks.

Physical examination revealed a fairly well-developed girl. The tongue was coated. The heart and lungs were normal. The abdomen was enlarged and tympanitic to percussion. In the upper left quadrant there was a mass about the size of a small grape fruit. This mass was freely movable and when first felt was found in the midline in the bladder area. It was regular in outline and smooth and cystic to touch and dull to percussion. By palpation of the mass we noticed that it had suddenly disappeared from the midline into the left upper quadrant and had almost disappeared under the ribs. By further manipulation we found that we could displace the tumor and place it over into the right upper quadrant beneath the ribs. There was some tenderness over the mass and slight rigidity of the abdomen.

Before operation, temperature was 99°, pulse, 96, respirations, 24. The leucocyte count was not made. Urine, clear amber, acid. Specific gravity, 1.012, albumen negative, sugar negative, acetone negative, white blood-cells 3 to 8 to H. P. F., occasional hyaline casts, amorph urates.

Dr. Charles F. Mitchell saw this child in consultation with Dr. Walter Andrus and myself. Previously, the child was seen by a pædiatrician. We all agreed that the tumor mass was causing an intestinal obstruction. Three of us agreed that it was cystic and the pædiatrician made a provisional diagnosis of intussusception. One diagnosis was omental cyst and another ovarian cyst and the third indefinite.

Under ether anaesthesia a median incision was made below the umbilicus about four inches long. With some difficulty a movable cyst was brought into the field of operation and delivered. It was found to originate from the mesentery of the ileum and about the size of a small grape fruit. It was occluding the portion of the bowel attached. A trocar was plunged into it and 290 c.c. of a dark bloody colored fluid was removed. The peritoneum was incised at its base and with gauze, the peritoneum was stripped from the sac and the wall enucleated. This portion of the bowel was collapsed and congested. The distal portion of the bowel was collapsed and the proximal distended. The mesentery was carefully repaired. The blood supply to the bowel was

preserved, peristalsis was noticed in the bowel, the abdomen was closed without drainage

The recovery was uneventful. The bowels moved normally several days after operation and the child left the hospital on the tenth day cured.

The *microscopical examination* of a section of the cyst wall showed it composed of three coats, an inner serous, a middle muscular with bands going in two directions, some lymph-tissue scattered between these two coats. The inner was a thick fibrous envelope undergoing calcareous changes.

A section from another portion of the wall shows the same three coats, the inner one composed of a hypertrophied endothelium.

The laboratory report on the contents of the cyst—290 c.c. of a dark bloody-colored fluid, culture, sterile. No chemical tests made. The fluid most likely was blood, serum or lymph.

CASE II—Private patient of Dr. Charles F. Mitchell, S.W., male, age twenty-six, Chestnut Hill Hospital. Seen with Doctors Cheston and McCloskey, February 8, 1925.

In July, 1924, Doctor McCloskey first treated the patient for what he thought was a mild attack of gall-bladder trouble. The appendix had been removed ten years ago. On February 4, 1925, he slipped on ice, following which the patient had pain in the left groin and left side of abdomen. There was no sign of any hernia. Bowels were moved by oil.

Examination—There was a mass in the upper portion of the abdomen a little to the left of the median line. The mass was slightly tender to touch, apparently smooth in outline and seemingly fairly well fixed. There was no history of any urinary disturbance. The mass felt like an enlarged kidney, and the diagnosis hinged between that of an enlarged, possibly cystic kidney, cyst or tumor of the spleen or tumor of mesentery or omentum.

X-ray taken by Doctor Pancoast at the University Hospital showed that the mass did not coincide with the line of the kidney and was, therefore, intra-abdominal.

February 27, 1925, the patient was taken to the Chestnut Hill Hospital. Following a hypodermic injection of morphine and atropine, gas anesthesia was administered. The incision made was about four inches in length through the left rectus muscle. The left kidney was found in good position and normal in outline. The spleen was of normal size and shape. To the left of the median line, a large mass was felt consisting of a mass of intestines tightly bound together by adhesions. The intestines and other structures of the peritoneal cavity were packed away with gauze-pads, the intestines were separated and the mass itself was found to be one situated between the layers of mesentery of the upper portion of the jejunum. The incision was made through one layer of the mesentery immediately over the mass and the tumor shelled out from its bed from between the layers of the mesentery. The blood supply of the jejunum was preserved, the wound in the mesentery sutured, and the abdominal wall closed.

Post-operative convalescence was uneventful, and the patient discharged cured, March 9, 1925.

The mass removed proved to be a cyst about the size of an ordinary grape fruit. When opened, it was found to be filled with a thick, sebaceous material. Diagnosis from pathological laboratory—sebaceous cyst.

CONCLUSIONS

The specimen from Case I is undoubtedly an enterogenous cyst as is verified from the microscopical picture of its wall. The fluid present in the sac was bloody. Unfortunately, the chemical analysis was not made. It may have been blood, serum, lymph or chyle. Nevertheless, conclusions based upon the character of the cyst contents can hardly be considered final, for as Dowd has suggested, the fluid that collects in a preformed cyst is probably

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a mere matter of chance, whether lymph, chyle, or blood from a ruptured mural vessel

The symptoms here present are typical, associated with the symptoms of intestinal obstruction, a very common complication. The diagnosis of a cyst was made as well as obstruction of the bowel. Omental cyst, the symptoms of which are almost the same as those of mesenteric cyst, was considered but the diagnosis of mesenteric cyst was not made previous to operation. Had we made the diagnosis instead of omental cyst or ovarian cyst, we would have been the first to have had made a correct one previous to operation or autopsy. Fortunately, our cyst was one that could be enucleated. Enucleation is the most satisfactory treatment when it can be done. This patient had an uneventful recovery and when seen several days ago, she was in the best of health and has had no abdominal disturbance since her operation.

The *second case* (Dr. Charles F. Mitchell's patient) is interesting because the contents of the cyst was a sebaceous-like material and, therefore, Doctor Mitchell considered it a dermoid cyst of the mesentery. Unfortunately, there was no hair or teeth in this sebaceous-like material and the laboratory did not report on the microscopic findings of the cyst contents or wall.

We cannot, therefore, prove that this specimen is a dermoid cyst of the mesentery. If we could, this case would be the first case reported as a dermoid cyst of the mesentery in a male. This would disprove the theory, mentioned by Dowd and many other authors, in speaking of dermoid cysts, that they always are due to an error in development in the ovary or some one of the epithelial structures. Higgins and Lloyd (1924) also state that no retroperitoneal or mesenteric dermoids have been reported in the male though they have occurred in the testis which is originally a retroperitoneal organ. This has been held as evidence that an ovary is responsible for the true dermoid when it occurs in the mesentery.

This specimen might be the remains of a tuberculous lymph-node or a degenerated hæmatoma or lipoma. A tuberculous abscess in the mesentery may present all the features of a true cyst and in childhood is the most common type of mesenteric cyst to be exposed by operation. Both Haworth²⁷ and Gould (*loc cit*) have reported such cases.

Because of the inflammatory nature of the cyst, it was adherent to the neighboring bowel and thereby lessened the mobility of the cyst. The bowels were constipated but there was no intestinal obstruction.

The symptoms here present are not as typical and do not warrant the correct diagnosis as in our first case.

This cyst was also enucleated and the patient had an uneventful recovery and has remained well.

I am greatly indebted to Doctor Mitchell for allowing me to report this case.

The most interesting part of the discussion of these cases is their origin and we believe with Higgins and Lloyd that the classification depends upon definitely defining first of all, the "true mesenteric cyst" as "Those which

occur in or near the mesentery and which are not malignant, dermoid, or parasitic, and do not arise in any normally placed retro-peritoneal organ "

Such cysts can then be classified as (a) Cysts of embryonic origin arising from mesodermal remnants incarcerated behind the developing peritoneum and subsequently migrating forward between its layers, (b) Cysts of intestinal origin—I arising in most cases as diverticula from the bowel during development and II possibly derived sometimes from persistent portions of the vitelline duct

In this, one of the most recent classifications, our first specimen a "true mesenteric cyst," will be classified under cysts of intestinal origin We cannot determine definitely whether arising as a diverticulum from the bowel during development or derived from persistent portions of the vitelline duct

Our second specimen is not a true mesenteric cyst We can only say that it is a sac containing a sebaceous-like material in the mesentery of the jejunum of a male patient If it is not a dermoid, it is possibly a tuberculous abscess, degenerated lymph-node, hæmatoma or lipoma

REFERENCES

- ¹ Deaver, H C ANNALS OF SURGERY, Phila, 1909, vol LV, p 618
- ² Frazier, C H J A M A, Chicago, 1913, vol LV, pp 97-99
- ³ Shallow, T A ANNALS OF SURGERY, Phila, 1925, vol LXXVI, p 195
- ⁴ Ryan, W J ANNALS OF SURGERY, Phila, 1926, vol LXXVII, p 567
- ⁵ Braquehay Arch Gen de Med Par, 1892, vol XXX, p 291
- ⁶ Ney and Wilkinson ANNALS OF SURGERY, Phila, 1911, vol LIV, p 115
- ⁷ Dowd, C N ANNALS OF SURGERY, Phila, 1900, vol XLII, p 515
- ⁸ Augagneur These de Doct, Paris, 1886
- ⁹ Alekion These de Doct, Paris, 1891
- ¹⁰ Moynihan, B G A ANNALS OF SURGERY, Phila, 1897, vol XLVI, p 1
- ¹¹ Jones, E G Surg, Gyn and Obst, Chicago, 1912, vol XV, p 1
- ¹² Benedict, A L Surg, Gyn and Obst, Chicago, 1913, vol XVI, p 606
- ¹³ Friend, E Surg, Gyn and Obst, Chicago, 1915, vol XXI, p 56
- ¹⁴ Rosenblatt, F Iowa St M Soc J, 1915, vol V
- ¹⁵ Willems, W Beitr Z klin chir, Tuebingen, 1913, vol LXXVI
- ¹⁶ Carter, R M Surg, Gyn and Obst, Chicago, 1921, vol LXXIII, p 544
- ¹⁷ Higgins and Lloyd Brit J Surg, Bristol, 1924-25, vol XII, pp 95-105
- ¹⁸ Rokitsansky Pathologische Anatomie, 1842
- ¹⁹ Virchow Klire Wabnacher, Berlin, 1887
- ²⁰ Ayers, J C Am Jour Med Science, 1906, vol CXXI, p 92
- ²¹ Niosi, Francesco Arch f Path Anat, etc, Berl
- ²² Klemm, Paul Arch of Path Anat, etc, Berlin, 1905, vol CLXXI, p 541
- ²³ Miller, R T Bull Johns Hopkins Hosp, 1913, vol XLIV, p 316
- ²⁴ Bauer, Albert Beitr Z klin Chir, 1910, vol LXX, p 829
- ²⁵ Haworth, J K Lancet, London, 1920, vol I, p 1269
- ²⁶ Timbal, R Rev de Chir, 1910, vol LI, pp 45-227
- ²⁷ Coley, W B ANNALS OF SURGERY, 1910, vol LI, p 512

TUMORS OF TENDON SHEATHS

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TUMORS of tendons and of tendon sheaths are very rare. This is the reason why no standard division or classification of them has been set up as yet, thus we find no chapters in standard books on pathological anatomy and surgery, which would specially deal with these diseases, excepting some short references.

Recently we had in our Clinic occasion to observe four cases of neoplasms of tendon sheaths. Besides which there was one case observed and given up to us in the Surgical Department of the General Hospital. I am indebted to Professor Ostrowski for the privilege of reporting it.

CASE I—M O, female, aged twenty-four, complained of a small swelling in her right thumb for one year. The swelling grew slowly, giving no pain. It hindered the flexion of the thumb and the grasping of things.

Examination—On the palmar side of the right thumb a hard well-defined uneven tumor was found. It was a little larger than a hen's egg, not painful and free of the phalanges and skin which was normal and movable.

The movement of the finger was very limited, the flexion of the joint especially being practically impossible, while the flexion of the phalango-metacarpal articulation was possible only within the extent of 15° to 20° . The tumor appeared to originate in the flexor tendon of the thumb.

Operation (Doctor Janik)—The tumor was exposed under local analgesia and easily separated from the surrounding tissues. Approaching to the base of the tumor it was seen that it was attached to the sheath of the flexor of the thumb. The tumor was removed together with a part of the sheath, which was closed with a single suture.

Macroscopic Examination—The surface of the tumor removed was broken up into many lobulations. On section some brighter stripes of connective tissue were seen, running from the capsule toward the centre and separating the remaining mass of the cartilage into lobules. The parts lying nearer to the tendon sheath seemed to be more opaque, hard and resistant to cutting. The specimen measured $4 \times 3 \times 3$ cm.

Microscopic Examination—Broad stripes of connective tissue with a small number of nuclei, surrounding lobules of hyaline cartilage. The opaque area was caused by the calcification of the external part of neoplasm (Fig. 1).

Microscopic Diagnosis—Chondroma with calcification.

CASE II—O W, male, aged twenty-five, stated that a tumor had been growing for three years on the plantar side of the second toe of the right foot. The tumor gradually increased, without causing any discomfort.

During the last two months the tumor grew rapidly and became painful. The pain increased during walking on account of boot-pressure.

Physical Examination—On the plantar side of the second toe of the right foot a growth was to be seen, as large as a hen's egg, hard and uneven, which pressed the toe up. The flexion was considerably limited, but the extension of the joints of the toe was not hindered.

The tumor seemed to be connected with the toe-phalanges.

Rontgen-ray examination showed a circular shadow of the tumor, against which the outline of the first and second phalanges of the toe were visible, the shadow being more opaque than that of the soft tissue, and less opaque than that of the neighboring bones. In the middle of this homogeneous shadow, an island of a darker area in the shape of a butterfly was visible, irregularly and sharply outlined. The limits of the bones were normal, a distinct line of demarcation between the spongiosa and compacta, however, was missing. The shadow of the second toe phalanges was more distinct than that of the neighboring bones, because the shadow of the phalanges and that of the neoplasm was intensified. Thus, it did not appear to be in any connection with the phalanges.

Operation (Doctor Ratajski)—Under local anæsthesia a longitudinal incision was made, exposing the tumor.

During the operation the difficulty of removing the tumor appeared so great that it was impossible to remove it without excartication at the metacarpophalangeal joint.

Macroscopic Examination—The toe with tumor removed was divided into two halves. The neoplasm was closely attached to the sheath of the flexor and was movable in relation to the phalanges.

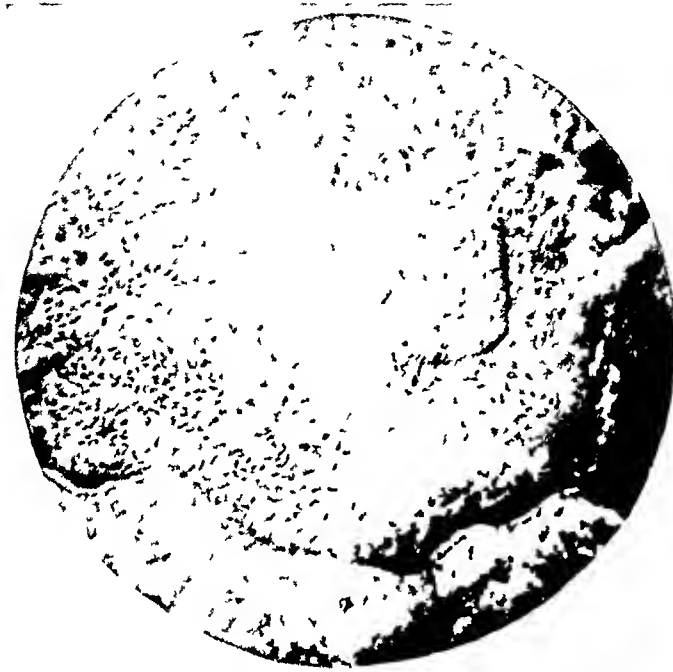


FIG. 1.—Case I. Chondroma of tendon sheath showing calcification.

The surface of the phalanges was even and distinctly separated from the mass of the neoplasm.

The tumor was well encapsulated, of a cartilagenous consistency, uneven and lobulated. It originated from the external surface of the flexor sheath, being organically connected with it. It surrounded the sheath and the tendon which pierced the tumor running within the canal formed by its sheath.

Microscopic Examination—Revealed the tumor as a chondroma. The connective tissue stroma surrounded the islets of the hyaline cartilage. The opaque area shown in the skiagram was due to calcification of a part of chondroma.

An examination of the borders of the neoplasm and of the tendon sheath showed close organic connection between the neoplasm and the sheath, the edges of the sheath were uneven and ragged, and the tissue of neoplasm penetrated the sheath in the shape of islands. Thus, there were no distinct and sharp limits between the sheath and neoplasm.

Microscopic Diagnosis—Chondroma with calcification.

CASE III—J. C., workman, forty-three years of age, complained of a growth over the dorsal surface of the right forearm. Fifteen years ago he was struck in his forearm with a heavy pole. Three months later he noticed a small swelling in the same place which increased, but gave him no pain. During the past twelve months it became painful, and grew rapidly larger. The movement of the wrist was painful.

Physical Examination—On the volar surface of the right forearm there was a tumor between the carpal joint and the upper half of the forearm, but not sharply out-

lined, in its distal end very painful. It was hard and free of the skin which was normal, and could be moved a little laterally.

The lymph-nodes in the axilla were not enlarged.

Operation (Professor Schiøtt)—The tumor was exposed by a longitudinal incision and separated from the surrounding tissue. After lifting the neoplasm it was found to be lying on the muscle layer of the forearm, attached to the sheath of the tendon of the flexor carpi radialis. In one place it had grown together with the tendon, and it was difficult to separate the mass from the tendon. Thus, it had to be removed with a part of the tendon.

The patient recovered without any complications.

Macroscopic Examination—The specimen removed consisted of a large circumscribed, lobulated and encapsulated mass, which measured 18 x 12 x 11 cm. On its surface a number of hard or soft translucent tubercles containing a mucous fluid were seen.

On the section the mass appeared to be composed of a gray tissue which was darker than the tissue of the capsule, and was of various consistency, *viz* on the periphery it consisted of a whitish, dense fibrous tissue, while the deeper parts were of a more soft consistency and looked brownish.

There were scattered areas of a more opaque appearance, very hard and difficult to cut. The largest of them nearly of the size of a pigeon's egg. There were also empty spaces, *viz*, dissected cysts.



FIG 2—Case II. Skiagram showed no evidence of connection of neoplasm with the phalanges.

Microscopic Examination—Sections taken from this growth show a neoplasm composed of rather mixed tissue. Chiefly it is composed of numerous spindle-shaped cells running in stripes in different directions, with a small quantity of intercellular substance.

In its whole this part of tissue corresponds to a typical picture of fusocellular sarcoma.

Apart from the fact that that tissue formed the main part of the neoplasm, it formed also nests and stripes amid the other substance, *viz*, cartilage of a homogeneous hyaline appearance. This cartilage had cells, irregularly arranged and of different sizes. Amidst that cartilagenous tissue there were areas of calcification, irregularly distributed. The trabeculae of cartilage in these places were calcified, and the periphery had a true bone picture. In some other places the islets of cartilage showed at their peripheries attenuation of the tissue, assuming gradually a mucous character. Somewhat further there were areas of what may be considered as myxoma.

Between all these tissues there were spaces filled with connective tissue running in irregular stripes. It was of a considerable density, and showed hyaline degeneration.

Thus, the whole was a mixed neoplasm composed of tissues of fusocell, sarcoma, fibroma, myxoma, chondroma, and osteoma.

A more exact revision of the section showed that the cartilagenous tissue constituted

in this neoplasm the material from which two other tissues, *viz*, the myxomatous and osteoid ones took their origin

It was endeavored to ascertain under the microscope the relation of the neoplasm to the tendon, because during the operation it was found that the tumor was connected not only with the sheath, but also the tendon itself. It was therefore important to decide, if the neoplasm originated from the tendon or from the sheath. It was seen in many sections that the tendon tissue is separated distinctly from that of the neoplasm which stood off from the tendon, which suggested that no organic junction existed between the tendon and the neoplasm.

Microscopic Diagnosis—Fibrochondromyxosteosarcoma

CASE IV—Z E, a married woman, aged forty, was admitted to the Surgical Clinic complaining of a growth over the volar surface of the right forearm. It appeared five

years ago, and has been increasing in size, gradually but slowly, without causing any pain.

During the last year the woman began to feel pain, and the tumor increased greatly, and hindered her work.

The patient did not remember having injured her forearm.

Physical Examination—

On the volar region of the right forearm, above the carpal joint, there was a swelling about the size of a fist, it was sharply limited and freely movable laterally, less, however, in the axis of the extremity. It was elastic, and the skin around it was normal. The limits of the tumor were sharply outlined while straining the flexors.

Between the skin and the tumor one could feel the tendon of *m. palmaris longus*. The movement in the carpal joint was normal.

Operation (Doctor Janik)—The tumor was exposed in local anesthesia. It was attached to the sheath of the flexor digitorum sublimis and surrounded the tendon for the space of 5 cm. The tendon was separated from the neoplasm which was excised together with a part of the sheath (Fig 7, d).

Macroscopic Examination—The mass removed measured $6\frac{1}{2} \times 3\frac{1}{2} \times 1$ cm and had the shape of an egg. Its surface was even and grayish. On one of the surfaces a canal was seen, covered with the tendon-sheath which had been excised together with the mass. The canal corresponded to the course of the tendon.

The tumor was hard and whitish in the periphery (on the section), soft and reddish in the centre. The tissue had a spongy appearance and blood could be squeezed out of it. The capsule of the neoplasm was thick and hard.

Microscopic Examination—The sections taken from the periphery of the neoplasm showed a fibrous connective tissue with scanty blood-vessels and cells. The nuclei of the cells were spindle-shaped and the fibrillæ ran in different directions.

In some places accumulation of cells could be noted, however, without any signs of malignant degeneration.

The capsule was thick, and showed hyaline degeneration.

On the sections taken across the middle of the tumor, numerous large and small spaces filled with blood were noticed, encroaching into the fibrous tissue. The red cells of the above-mentioned spaces preserved their unchanged appearance. There were no deposits of blood pigment. The walls of these spaces were covered with endothelium, and were sharply limited from the surrounding tissue. There was no evidence whatever

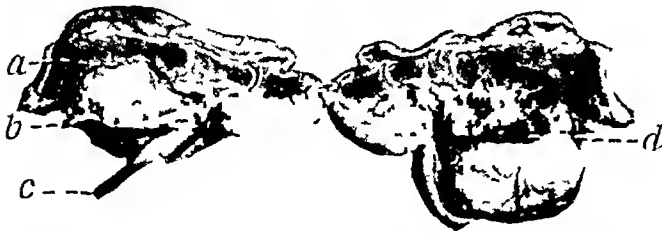


FIG 3—Case II. Longitudinal section of neoplasm. *a* Distinct limit between the phalanges and neoplasm. *b* The tendon sheath of the external surface of which the neoplasm came out. *c* Flexor of the toe. *d* The canal within the neoplasm in which the tendon runs.

of any formation of new tissue which would tend to organize these spaces. This part of the tumor had an angiomatous appearance.

In the nearest neighborhood of these angiomatous spaces the fibrous tissue had become loose and resembled a myxomatous tissue. There were, however, no characteristic star-cells.

At the first glance one had an impression that this was an organized hæmatoma. But there were other signs which proved to the contrary. The clinical course (gradual growth), no connection with the surrounding tissue (the tumor was well encapsulated and even), macroscopic picture (on section taken immediately after the operation areas filled with fresh, not coagulated blood), finally the microscopic appearance (spaces bordered with their own walls contained unchanged blood, and absence of old pigment). All this proved that the tumor was a hæmangiofibroma.

CASE V—H. G., a female, aged thirty-two, noticed about eight years ago, a light swelling on her left forefinger which was painful and became larger in last six months. The patient stated that the swelling was originally on the palmar surface of the finger, and later deviated gradually to the radial side of the finger.

Physical Examination—

Disclosed a swelling about the size of a walnut, localized on the radial surface of the left forefinger, near the interphalangeal joint. It was tender on pressure, free of the skin, and movable laterally especially towards the palmar side.

It moved when the finger was flexed, but it did not hinder the normal movement of the finger.

Operation (Doctor Guica)—The tumor was excised in local anæsthesia. It was attached by a long pedicle to the sheath of the flexor of the finger mentioned.

Microscopic Examination—A section of the tumor showed a varied appearance. The mass of the neoplasm was composed chiefly of a dense fibrous connective tissue which at some places showed hyaline degeneration.

In some places, there was a large quantity of cells grouped in nests and cords. The nuclei of the cells were spindle-shaped.

The above-mentioned nests of cells finally flowed together in a homogeneous mass of sarcomatous tissue. In these places there was no further evidence of the density of the fibrous tissue.

The whole tumor appeared to be a fibroma with malignant degeneration in some places. The arrangement of cells resembled the early period of proliferation of an endothelioma. Dilated lymphatic spaces covered with a visible endothelium, however, were missing.

Microscopic Diagnosis—Fibroma sarcomatodes.

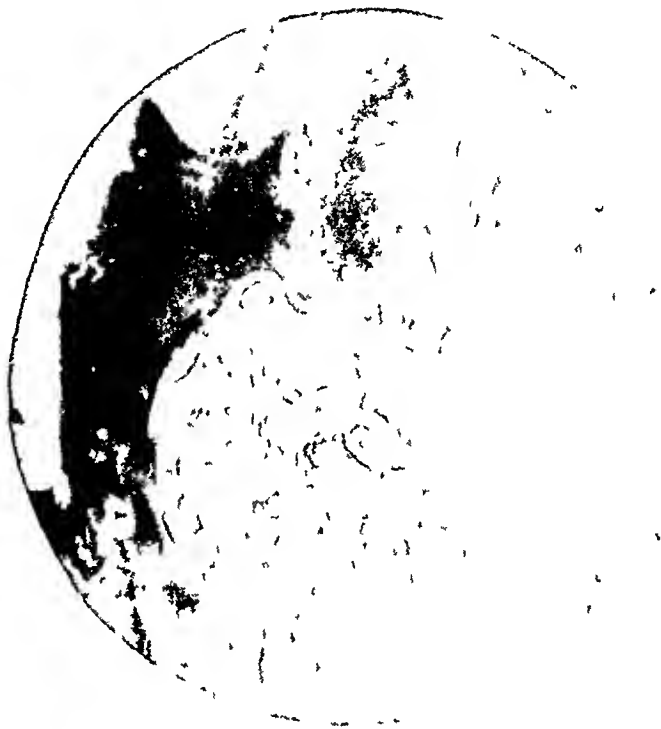


FIG. 4—Case II. Chondroma of tendon sheath showing calcification.

Before we proceed to discuss tumors of tendon-sheaths, let us say a few words about the tumors of the tendons themselves

They are very rare and some writers as Ombredanne, Buxton, believe they do not exist at all, and maintain that the cases described were not examined minutely enough, they should rather be considered as secondary growths, originating from the tendon sheaths, and only later encroaching on the tendons. Thus, in order to separate the tumor we must, during the operation, remove also a portion of the tendon. The microscopic examination



FIG 5 —Case III. Fibrochondromyxosarcoma. a The canal on the surface of the tumor in which the tendon ran

shows then sharp limits between the neoplasm and the normal tendon tissue.

The cases of tendon neoplasms known so far, are fibromata, osteomata, and sarcomata (Schultz, Weir, Montprofit, Schwobel, Lagrange, Hayem-Giaux, Broca and others).

The neoplasms of tendon sheaths are more common than those of the tendons. The former, arising from the sheaths, and especially from the external surface do not limit the movement of the tendon, except when their size is considerable and when they surround the tendon on a larger area. It should be pointed out that neoplasms which originate in the internal part of the sheath lead to an early limitation of the movement of the tendon.

Malignant tumors having an inclination to infiltrate the neighborhood rapidly produce the same state.

The clinical diagnosis in such cases is not easy, because such growths can also imitate the neoplasms of muscles or of the connective subcutaneous tissue, or some inflammatory diseases. We will return to this question later.

The classification of the primary neoplasms of tendon sheaths is as follows:

I. Fibroma, grows slowly, rarely reaching large dimensions. It is generally hard. The clinical diagnosis is difficult, as the same course can be taken by giant-celled myeloma, and only the microscopical examination is decisive. So far, only thirteen cases of fibroma of tendon sheaths have been described (Nelaton, Buxton, Petzold, Sendler, etc.).

II. Lipoma is more frequent, and occurs in two forms: as lipoma arborescens and simplex. Clinically both can not be distinguished from one another. They may both grow within the sheath, surrounding the tendon, or outside it, connected with the sheath directly or by means of a pedicle (Strauss, Tichon, Sendler, Sprengel, Billioth, etc.).

III. Chondroma is very rare, of a small size and hard consistency. When

TUMORS OF TENDON SHEATHS

examined microscopically, it appears usually to be composed of islets of hyaline cartilage, lying between areas of fibrous tissue. In the centre of such islets places of calcification and even of ossification are often visible.

During the physical examination it is necessary to ascertain as far as possible, (a) whether the tumor does not arise from the bone in which case the X-ray examination shows the changes in the structure of the bone, the exact connection of neoplasms with the bone being found by palpation, (b) whether the tumor does not arise from the muscles, (as in cases described by Enichsen, Gibson, etc.), or from connective subcutaneous tissue, (c) whether it is not a ganglion which is usually of cartilagenous consistency, showing symptoms very similar to those of chondroma, especially in cases when chondroma lies in places characteristic of the ganglion.

With the exception of four cases already mentioned in different papers (Billroth, Chauvain-Roux, Delbet, Pallailon), three new cases were reported recently.

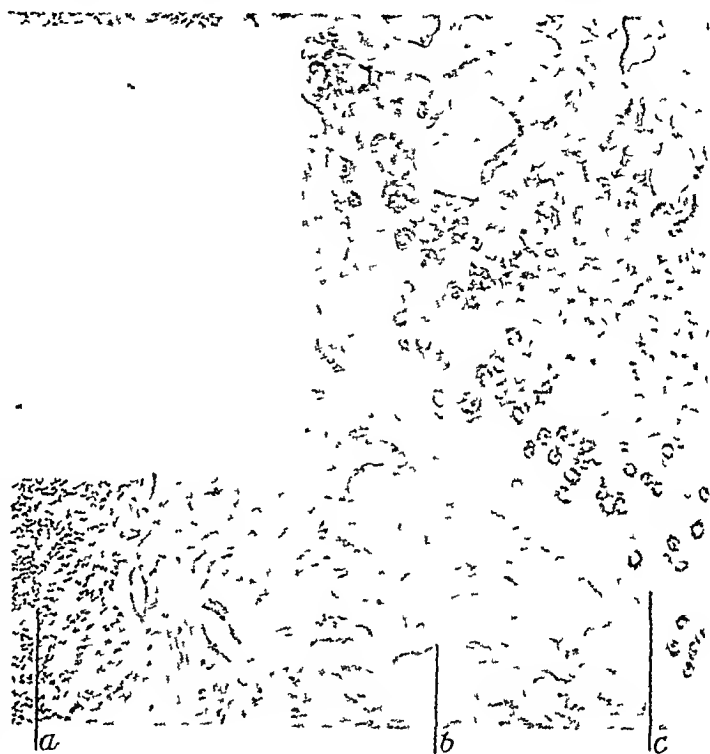


FIG 6—Case III. Fibrochondromyxosteosarcoma. a The sarcomatous tissue. b Myxomatous tissue. c Cartilagenous and osteoid tissue.

I BUXTON (1923). A professional violinist complained of pain and swelling in his left hand for two months. The swelling was soft, non-fluctuating. There

was no evidence of an injury. At the operation an encapsulated mass was found with a pedicle attached to the tendon sheath of flexor, distal to the metacarpophalangeal joint of the left ring-finger. It measured $2\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{1}{2}$ cm.

Microscopic Diagnosis—Chondroma simplex with areas of calcification.

2 BUXTON. No clinical history of the case. The diagnosis was fibroma multiplex of tendon sheaths. Microscopic appearance corresponded to fibrochondroma.

3 BECK (cited by Buxton). The tumor was attached to the tendon sheath of flexor of the forefinger.

Microscopic Diagnosis—Chondroma with calcification.

To the above, our two cases should be added.

IV Angioma, described by Pizzorno, occurs very rarely.

V Sarcoma occurs as sarcoma globo-, fuso-, and giganto-cellulare. The commonest of sarcomas and generally of all tumors of tendon sheaths is

A Sarcoma giganto-cellulare (myeloma, xanthosarcoma). Its clinical picture and pathology is of great interest, to which a great many papers have been devoted. The first of these papers appeared in the second half of last

century At that time the different forms of sarcoma were not distinguished, (Chassaignac, Czeiny, Billroth Spenzei, Wells, Paquet), Heurtau's studies, however, solved the question He gave the tumors the name of myelomata, as distinct from the sarcomata, based on the clinical course and microscopical picture, in which he found giant cells (1891) Seven years later the French pathologist Dor found in these tumors cells containing fat, another characteristic of myeloma Further French works followed (Venot, Mallerbe, Reveidin), ascertaining the presence of the brownish pigment of sanguineous

origin, distributed in fine droplets intra- and extra-cellularly The pigment corresponds to the Prussian blue reaction for hæmosiderin

Later the German authors began to take interest in the above kind of tumors (Rosenthal, Fleissig, Landois, Hartert, etc) without accepting for them the French name *myeloma*

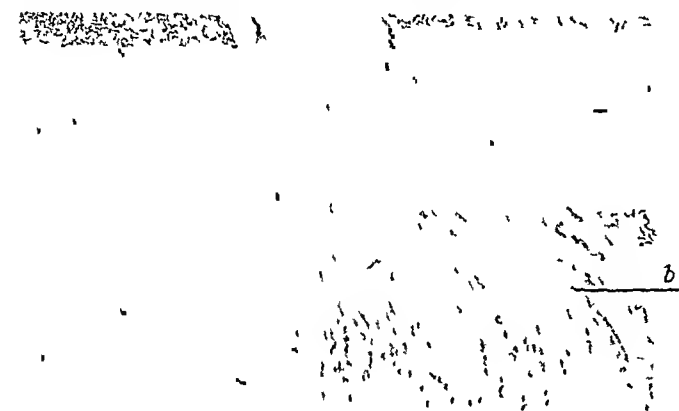


FIG 7—Case III The tendon tissue limited sharply from the tissue of neoplasms

which is still used in France, and giving them different names xanthoma, xanthosarcoma, giant-celled sarcoma, etc

Etiology—The etiology of myeloma tumors is as generally in neoplasms unknown Injury is quoted in the majority of cases as a provoking factor The relation of trauma to the neoplasm is very differently explained (direct irritation of latent neoplasm cells, causing the inflammation and the formation of granulating tissue, on the ground of which an malignant growth develops, the producing of locus minoris resistentiæ according to the bacteriological theory

The injury plays indeed an important part as shows the fact that the disease occurs on the upper extremities more frequently than on the lower ones (according to Rosenthal 54 17, according to Touineaux, 66 27), more frequently on the palm and fingers than on the forearm (47 7, 50 6), lastly more frequent in men than in women (37 30, 55 38)

Pathology—The size of the tumor depends on the localization, *vis*, the tumor is larger, the more proximally it lies Therefore the average size of a tumor on the finger is that of a walnut, while on the palm and in the region of ankle-joint may be as large as a hen's egg (except the tumors on the hand which are subject to malignant transformation), and finally on the forearm it reaches to the size of a fist or still more It is generally very limited and encapsulated, and only rarely does infiltrate the neighboring tissue It may surround the tendon and nerves, having a longitudinal shape The tumor is of yellow or gray color, in the last case with yellow areas in

proportion to the amount of lipoid. Further in many of them brownish areas are found as remnant of forearm hæmatomata (blood effusion). The consistency is elastic, rarely soft, showing false fluctuation (if any at all) causing numerous mistakes in diagnosis (the symptoms being similar to those of tenosynovitis).

Symptoms—Generally after an injury the swelling appears and increases in size gradually but slowly, seldom causing limitation of movement of the extremity concerned, pain or other discomfort. No metastases are present, although some authors have mentioned them. These metastases however were due to true sarcomata. Sometimes, after the removing of the tumor a new swelling may grow in the same place, which must be considered as a false recurrence due to an incomplete removal of the neoplasm, especially in case of tumors of an infiltrating character. Thus, they may recur locally but they form no metastases.

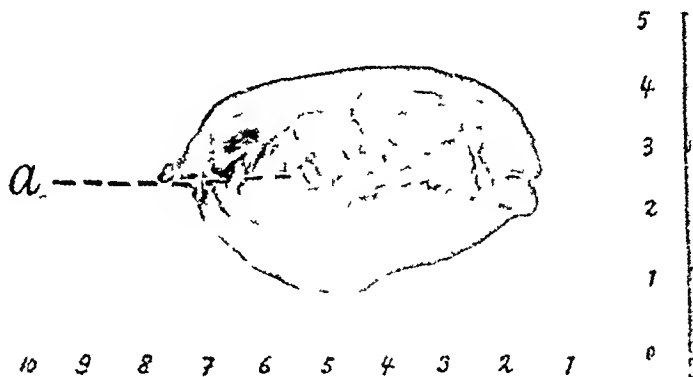


FIG. 8—Case IV a Tendon sheath

Microscopic Pathology—This is very characteristic. Some principal and characteristic components of such tumors must be distinguished, although not all often must be found in each case.

a The growths are lobulated and well encapsulated. From the capsule stripes of connective tissue run toward the centre dividing the growth into many lobules. The connective tissue contains blood-vessels and shows a hyaline degeneration. From these stripes run bundles of fibrillæ surrounding nests of cells and finally single cells, gradually becoming smaller and smaller. The shape of the cells is various: small, large, irregular, polygonal, rounded, spindle-shaped, etc.

b Giant cells containing a variable number of nuclei. Sometimes it is difficult to find these cells, and it is necessary then to examine all parts of the tumor. It should be added that often in tumors of the forearm the above cells cannot be found at all. Rosenthal states to have found giant cells only in one case of myeloma out of seven cases observed, it should be pointed out however that even in this case the neoplasm was, originally localized on the hand, and only secondarily passed on to the forearm.

c Lipoid cells are large, vesicular, bright, similar to the xanthoma-cells and containing round or oval-shaped nuclei, often excentrically situated further plasma honeycomblike tissue (Weben-, Schaum-zellen) which is seen whenever the specimen was subjected to the influence of liquids dissolving fats (alcohol, ether, xylol). On the other hand, if the specimen is congealed the empty spaces are filled with crystals and fine droplets of fat. In the

polarimeter we perceive doubly refracted light, and in Sudan III reaction the lipid cells become red-yellow. This fat-substance is a cholesterol ester of fat acid. On account of the increase of cholesterol in blood (hypercholesterolemia) crystals of cholesterol form local deposits in sheaths and tendons (Pinkus, Pick, Pringsheim). As consequence of irritation caused by the deposits of cholesterol results xanthosarcoma.

d Numerous blood-vessels having thick walls affected by hyaline degeneration.

e The presence of pigment deposits of sanguineous origin. The macroscopic examination shows dark brownish areas on the section and on the surface of the tumor. The microscopical findings of these places shows numerous crystals of hæmosiderin, both intracellularly and extracellularly. When exposed to the influence of potassium ferrocyanide it assumes a blue color.

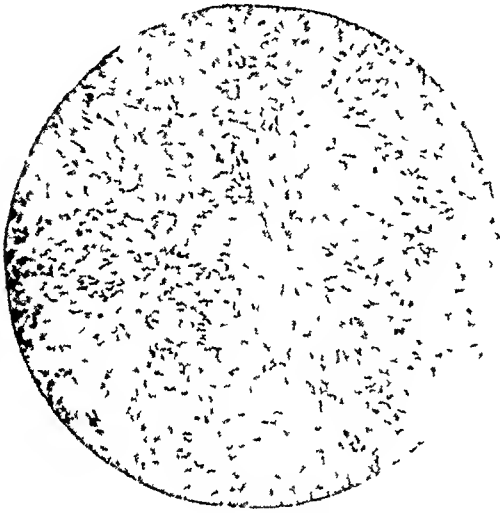


FIG. 9.—Case IV. The fibromatous area.

This pigment is the remnant of old extravasations of blood.

It must be added that myelomata are by some authors of recent years considered as granulomata of tendon sheaths of inflammatory origin (Fleissig, Bell, Broders, Buxton, etc.).

B Sarcoma fusocellulare and globocellulare. As a matter of fact it

is a malignant neoplasm and differs from the giant-celled sarcoma in its clinical symptoms and histological picture in which the giant cells and lipid cells are missing, besides Sudan III reaction is negative and the double refraction of light in the polarimeter is missing. The capsule may be present but the surface of neoplasm is generally without any lobulations. Most frequently it is of an infiltrating character.

Torneaux in 1913 reviewed the literature of 93 cases of sarcomata of tendon sheaths. Fifty-four of them were giant-celled sarcomata and 37 fuso- or globo-celled sarcomata.

To these statistics some new cases reported recently must be added. Most of them are xanthosarcomata.

1 HARTERT (1923).—A woman, aged fifty-eight, had a slowly developing tumor which grew to the size of a fist and sprang from the sheath of the tendon of m. tibialis posterior, grown together with the internal malleolus, the articular capsule and blood-vessels.

The excision of the tumor. Microscopic diagnosis. Xanthosarcoma.

2 HARTERT.—A man, aged about thirty-one, had a tumor as large as a fist, attached to the sheath of the m. tibialis anterior, grown together with the internal malleolus and articular capsule.

The growth was extirpated. Microscopic diagnosis. Xanthosarcoma.

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3 HARTERT—A woman, thirty-five years of age, had for sixteen years a tumor of the size of a fist over the os cuboideum

Pirogot's amputation Microscopic diagnosis Xanthosarcoma

4 HARTERT—A man had a tumor originating from the tendon sheath of second finger It was removed Microscopic diagnosis Xanthosarcoma

5 HARTERT—A neoplasm in connection with the tendon sheath of the flexor of the fifth finger of bean size

The excision Microscopic diagnosis Xanthosarcoma

6 FLEISSIG (1923)—A woman, thirty-eight years of age, had for two years a growth arising from the sheath of the flexor of the left forefinger Clinical diagnosis panarium Microscopic diagnosis Granuloma

7 FLEISSIG—A woman, twenty-two years of age, during the past nine months a tumor appeared about the size of an American walnut, arising from the tendon sheath of the flexor of the right forefinger Microscopic diagnosis Granuloma

8 FLEISSIG—A woman had a swelling arising from the tendon sheath of thumb flexor Excision Microscopic diagnosis Granuloma

9 BUXTON (1921)—A young woman noticed a swelling, a little larger than a pea which was attached to the sheath of the long extensor of the right thumb Removal Microscopic diagnosis Giant-celled myeloma

10 BUXTON—A woman, aged twenty-four, had a swelling of the size of a split pea attached to the tendon sheath of the right thumb flexor

Excision Microscopic diagnosis Giant-celled myeloma

11 KROGIUS (1922)—A woman, twenty-nine years of age, had for ten years, a fist-sized tumor arising from the tendon sheath of the m. tibialis anterior, grown together with the tendon of this muscle Excision Microscopic diagnosis Xanthosarcoma

12 KROGIUS—A woman, aged fifty, noticed twenty-four years ago a small tumor which grew slowly and gradually reaching the size of a walnut It was connected with the tendon sheath of the flexor carpi radialis Excision Microscopic diagnosis Xanthosarcoma

13 KROGIUS—A man, aged forty-eight, complained of a walnut-sized growth which sprang from the sheath of the extensor tendon of the second finger Excision Microscopic diagnosis Xanthosarcoma

14 KROGIUS—A woman, twenty-one years of age, had since the past three years a tumor of the size of a hen's egg The tumor was connected with the tendon sheath of flexor hallucis longus Excision Microscopic diagnosis Sarcoma fusocellulare

After one year followed a recurrence which was removed Exact microscopic examination showed xanthoma cells and doubly refraction of light No evidence of giant cells

Thus we obtain the number of 70 cases of myeloma of tendon sheaths reported so far in literature It must be added however that this number may probably be increased, if the American literature be duly revised We were only able to review the American journals of some last years

Finally we must point out that some authors do not distinguish sarcomata gigante-cellulare from true sarcomata, and therefore some of them suggest radical operation including amputation of the extremity while they are quite benign in their clinical course, and may probably be that they are as mentioned above, inflammatory granulomata Therefore, as such, they ought to form a separate group among tumors of tendon sheaths We cannot, however, express our precise opinion, as we had not any such case in our observation

The tendon sheaths are no rare places where mixed tumors occur They may be composed of a benign neoplasm tissue such as fibrochondroma, or,

sometimes, they assume a malignant character, *e g*, chondrosarcoma, fibrochondrosarcoma, etc, and in our case fibrochondromyxosteosarcoma. Among cases reviewed by Tournaux, (Sonbeyran, Morestin, Broca, Mayer, Billroth, Buxton) mixed tumors are found quite often. Our cases belong to the most interesting ones.

Differential Diagnosis—The clinical diagnosis of the above neoplasms is difficult, often possible only during or even after the operation on base of the microscopic examination.

Let us consider the commonest tumor of the tendon sheath, *viz*, the sarcoma and try to distinguish successively the diseases that may be taken into account here.



FIG 10—Case IV The angiomatous area

a Sarcoma of tendon is rarer and characterized by early limitation of the movement of the tendon. If it has a smaller inclination to the infiltration into the surrounding tissue, it will be movable if the tendon is brought into action.

The sarcoma of the tendon sheath, however, can give the same symptoms, if it affects the tendon secondarily, surrounding it from all sides. During the operation it is necessary to remove the sheath together with a part of the tendon. The microscopical examination shows then that the tendon tissue is unchanged and the limit between it and the neoplasm tissue is sharply outlined. On the other hand, if even a distinctly outlined sarcoma comes out of the tendon itself it may be only slightly movable, if the physiological movement of the tendon is small.

b Benign tumors of tendons are very rare, and we can therefore leave them unconsidered.

c Benign tumors of tendon sheaths: fibroma grows slowly, without attaining a large size, chondroma grows slowly, too, and has a hard consistency, lipoma can appear symmetrically or multiplex but not symmetrically, showing a false fluctuation. Sometimes it is lying under the fascia and then it grows along the tendon, giving a longitudinal swelling which can imitate chronic tenosynovitis.

d Ganglion tendinosum appears generally on the dorsal region of the forearm (sarcoma reversally) and is small in size, spherical, and disappears after pressure.

e Tenosynovitis tuberculosa granulosa is easy to distinguish from the sarcoma which has malignant symptoms but it is difficult to distinguish it from giant-celled myeloma, because the shape, localization, clinical course and symptoms can be similar in both diseases. In tenosynovitis the move-

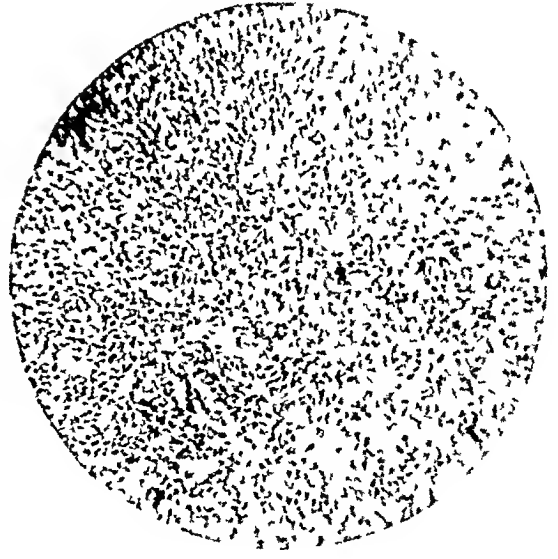
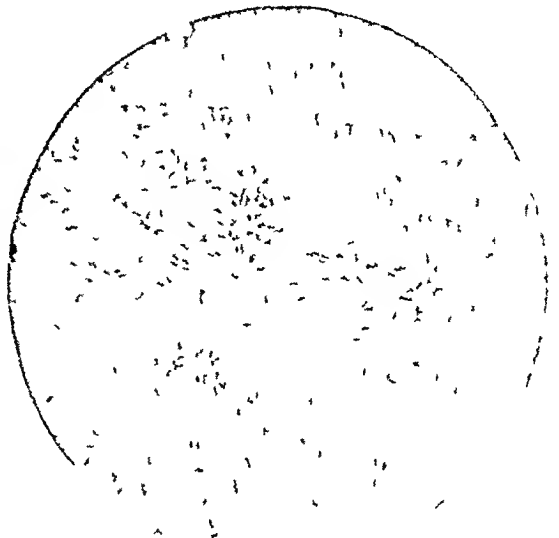
TUMORS OF TENDON SHEATHS

ment can occur earlier, and the consistency of the swelling is softer. Other movements must be taken into consideration, in order to ascertain the diagnosis, *vis*, the general physical symptoms, appearance and condition of patient, function findings, etc.

f. The tumors of other soft parts (muscles, fascia, etc.) too, can render

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<p>FIG 11—Case IV</p> <p>FIG 12—Case V</p> <p>FIG 13—Case V</p> <p>FIG 14—Case V</p>	<p>The loose fibromatous area</p> <p>Dense fibrous connective tissue</p> <p>The nests of spindle-shaped cells</p> <p>Homogeneous collection of cells</p>	<p>Hyaline degeneration</p>
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the diagnosis difficult, as it imitates entirely the tumors originating from tendon sheaths.

As it may be seen from the above, it is very difficult, often even impossible to distinguish the sarcoma of tendon sheaths from other diseases which we have quoted.

Prognosis—The prognosis of benign tumors is favorable. The excision of such tumors has no influence on the function of the extremity, even if they

have grown together with the tendons. The affected part of the tendon can easily be excised, and the remaining ends of the tendon can be stitched together, the tendon being prolonged in case of need.

The prognosis of giant-celled myeloma is good, because the tumor is easy to remove and does not form any metastases.

The worst prognosis is that of sarcoma.

The prognosis in regard to the function of an extremity is better in neoplasms of the fingers and hands than in the neoplasms of forearm where the growth (*e g*, myeloma) is usually larger and the excision consequently more difficult.

Treatment—Depends mainly on the character of the neoplasm. In the majority of cases it is sufficient to apply the local excision of the tumor. The amputation and exarticulation of an extremity is made only in severe and malignant cases.

SUMMARY

1 Primary tumors of tendons are very rare. The commonest of them are the sarcomata.

2 Primary tumors of tendon sheaths are more frequent. The commonest among them are the giant-myelomata (granulomata).

3 The giant-celled myeloma seems to be caused by some injury or irritation. It is an inflammatory granuloma, and should therefore be excluded from the group of neoplasms, and included in that of inflammatory disease.

4 The following classification and terminology of the tumors of tendons and tendon sheaths should be adopted.

A Neoplasms

I Neoplasms of tendons

1 Benign neoplasms: fibroma, osteoma, chondroma.

2 Malignant neoplasms: sarcoma.

II Neoplasms of tendon-sheaths

1 Benign neoplasms: fibroma, lipoma, chondroma, angioma.

2 Malignant neoplasms: sarcoma.

3 Mixed neoplasms.

B Inflammatory and other tumors: tendovaginitis tuberculosa, granuloma (the former myeloma), ganglion, etc.

5 The differential diagnosis between the tumors of tendon sheaths and inflammatory diseases especially tendovaginitis tuberculosa granulosa is difficult.

LITERATURE

¹ Buxton. Br. Journal of Surgery, 1923, vol. x, p. 40.

² Chalutow-Anitschkow. Munch. med. Wochenschrift, 1913, Nr. 46, p. 3.

³ Chauvau-Roux. Bull. Mem. Soc. Anat. de Paris, 1920, vol. xc, p. 4.

⁴ Czerny. Archiv. fur klin. Chirurgie, 1904, No. 10.

⁵ Fleissig. Zeitschrift fur klin. Chirurgie, 1913, vol. cxvii, p. 305.

⁶ Fritsch. Beitrage zur klin. Chirurgie, vol. Ix, p. 344.

TUMORS OF TENDON SHEATHS

- ⁷ Hartert Beitrage zur klin Chirurgie, vol lxxiv, p 546
- ⁸ Hoessli Beitrage zur klin Chirurgie, vol xc, p 168
- ⁹ Janik Polski Przegląd chirurg, 1925, No 3
- ¹⁰ Krogius Acta chirurg Scand, 1922, vol lv, No 4
- ¹¹ Kusniecowski Archiv fur klin Chirurgie, 1923, vol cxliv
- ¹² Landois Beitrage zur klin Chirurgie, vol xcvi, p 56
- ¹³ Montprofit Bull de la Soc Anat de Paris, 1891, p 40
- ¹⁴ Morestin Bull de la Soc Anat de Paris, 1890, p 529
- ¹⁵ Muller Archiv fur klin Chirurgie, vol lxxiii, p 358
- ¹⁶ Pincus-Pick Deutsche med Wochenschrift, 1908
- ¹⁷ Pringsheim Deutsche med Wochenschrift, 1908
- ¹⁸ Ollerenshaw Br Journal of Surg, 1923, vol x, No 40
- ¹⁹ Rosenthal Beitrage zur klin Chirurgie, vol lxiv, p 577
- ²⁰ Schultz Virch Archiv, vol xcvi, p 123
- ²¹ Schwarz Munch med Wochenschrift, 1908, p 1235
- ²² Strauss Surgery, Gynecology and Obstetrics, 1922
- ²³ Thorn Archiv fur klin Chirurgie, vol lvi, p 593
- ²⁴ Tourneau Revue de Chirurgie, vol xlvii, p 817
- ²⁵ Weil Beitrage zur klin Chirurgie, vol xciii, p 617

METACARPAL CENTRAL GIANT-CELL TUMORS

By EMILE DUSKES, M D

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THE purpose of this communication is to emphasize benign tumors of the metacarpal bones with particular reference to the giant-cell tumor and its differential diagnosis. Because of the rarity of giant-cell tumors in this location, it is felt that the following case is worthy of report.

CASE REPORT—Miss M G, white, age seventeen years, was admitted to the service of Dr F S Lynn at the University Hospital, September 17, 1926. The history was

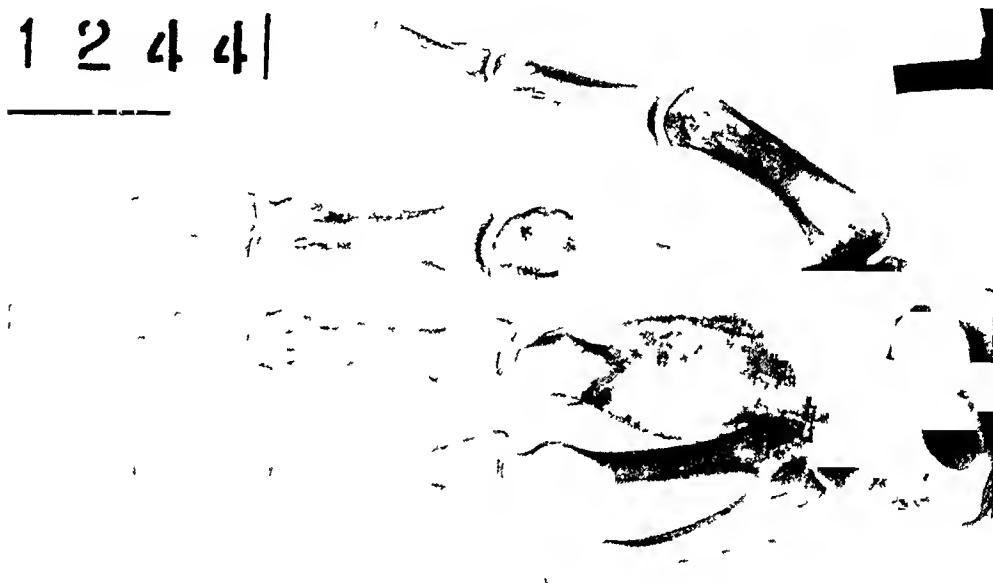


FIG 1—Rontgenogram anteroposterior showing involvement of third metacarpal bone the expanded and thinned-out cortex the trabeculations and the limitation to one bone

essentially negative, with the exception that about one year previous to admission, she struck the back of her left hand, following this injury she noticed the development of a lump near the centre of the dorsal surface of the hand. This had gradually increased in size, but it was not painful.

Examination of the hand showed a non-inflammatory swelling over the third left metacarpal bone, extending almost to the head of the bone. This was approximately oval in shape, fairly firm and not tender. There was no disturbance in function.

The Rontgen examination showed (Fig 1) a marked enlargement of the third metacarpal bone of the left hand. The shaft was expanded, the cortex was very thin but intact. The entire bone, with the exception of the head, was involved. There were fine trabeculations throughout. There was no destruction of the surrounding bones. No new bone formation was seen, nor were other lesions noted. Doctor Lynn performed the usual curettement operation.

METACARPAL CENTRAL GIANT-CELL TUMORS

The pathological material in this case consisted of a yellowish-red soft tissue intermingled with blood, having more or less the appearance of placental curettage. There was no bone or firm tissue present.

Microscopic sections (Fig 2) revealed a mass consisting of many large multinucleated cells of the "Epulis type," held in a loosely arranged stroma composed of spindle-shaped cells. Numerous blood-filled capillaries were present.

Comment—It is unnecessary to enter into controversial discussion as to the origin of giant-cell tumors except to call to mind the two main theories, viz (1) The neoplastic theory which holds that the lesion is a true tumor, having its origin in bone-marrow, (2) the non-neoplastic theory which holds that these tumors are the result of chronic inflammation or chronic irritation, such as a chronic hemorrhagic osteomyelitis (Barrie¹), or a faulty repair phenomenon (Malloiy²), or, as Ewing³ believes, the end result of a bone cyst.

The first view depends essentially upon the origin of the giant-cell from the bone-

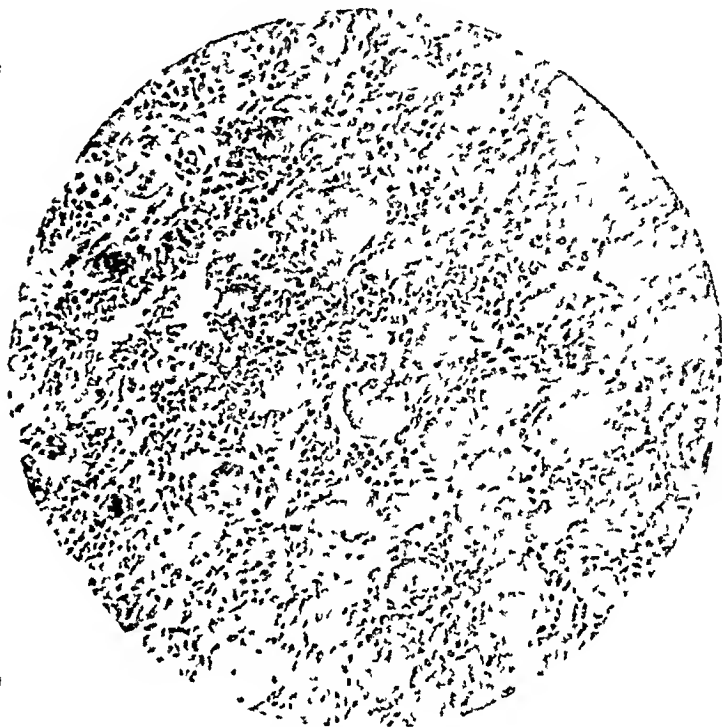


FIG 2 —Section of tumor showing giant cells and stroma
Pathology No 14727

marrow, that is, from the osteoclasts. To-day very few adhere to this theory. Apparently the giant-cells are derived from the endothelial cells of the blood-vessels or from monocytic infiltration from the blood. The giant-cells are of the true foreign body type such as are found in the epulis of the oral mucous membrane. Although giant-cells are encountered in the walls of bone cysts and particles of bone tissue are found in giant-cell tumors, nevertheless there are certain differences which might have an important bearing pointing to a difference in etiology, although as yet not correlated nor thoroughly understood.

In the case now detailed the history, roentgenogram and pathological findings permit no doubt as to the benignancy of the lesion. All the twenty-five points of diagnosis between benign and malignant bone tumors, as collected by Codman,⁴ are present. In this respect the case is typical.

Central giant-cell tumors have the same general appearance in all the bones. The majority of the recorded cases have occurred after the second decade of life and the lesion has been found in the epiphyseal end of the bone. Contrasted with this is the bone cyst, which constitutes the largest number

of cases in the first two decades of life and is observed in the shaft of the bone, this Bloodgood⁵ has shown

In the metacarpus giant-cell tumors are very rare. In 1920, from his immense experience, Bloodgood describes only one case which was also in the third metacarpal bone of left hand. Here, diagnosis was obscured by a large surrounding oedema complicating picture and producing erroneous impression of a sarcoma. Apparently no other cases have been recorded in literature.

The most important clinical aid to the diagnosis is the age of the patient. Bone cysts are most prevalent before the age of twenty, and, as Phemister and Gordon⁶ state, are essentially a disease of the growing period and rarely begin after adult life is reached. In adults, neoplasms predominate. Our patient was seventeen years of age, this favored a diagnosis of bone cyst. Although solitary cysts have been encountered in other bones of the body, usually, however, they are multiple.

The primary or original site in our case was not clarified by the roentgenogram. Both the epiphysis and part of the diaphysis were destroyed. Of true tumors the central chondromata are the most common, next in frequency appear the myxomata, both of which are more often noted in the phalanges rather than in the metacarpals. These usually occur in adults. These tumors frequently lack the appearance of trabeculations or the "stippling" of Rose and Carless,⁷ which are due to the presence of scattered calcareous masses. Moreover, more of the epiphysis remains than is seen in the giant-cell tumor, where only a mere shell is left. When the differences are not distinct, the ultimate diagnosis will depend upon an exploratory operation.

Osteomata and periosteal lesions, as a rule, offer no difficulties. Malignancy manifests itself in the roentgenogram.

SUMMARY

A case of central giant-cell tumor of third metacarpal bone of left hand is reported in girl aged seventeen years. It is a rare situation for this condition. A brief discussion of its etiology and differential diagnosis is given.

BIBLIOGRAPHY

- ¹ Barrie, G., and Hillman, O. S. Hemorrhagic Osteomyelitis. *Surgery, Gynecology and Obstetrics*, vol. xix, p. 42, July, 1914.
- ² Mallory. Quoted by Codman.
- ³ Ewing, J. A Review and Classification of Bone Sarcomas. *Archives of Surgery*, vol. iv, p. 485, May, 1922.
- ⁴ Codman, E. A. Registry of Bone Sarcoma. Twenty-five Criteria for Establishing the Diagnosis of Osteogenic Sarcoma. *Surgery, Gynecology and Obstetrics*, vol. xlii, p. 381, March, 1926.
- ⁵ Bloodgood, J. C. The Diagnosis and Treatment of Benign and Malignant Tumors of Bone. *Journal of Radiology*, vol. 1, p. 147, March, 1920.
Idem. Bone Tumors, Central in the Phalanges of the Fingers and Toes, Chondroma, Myxoma, Giant-cell Tumor. *Jour of Orth Surg*, vol. ii, p. 597, November, 1920.
- ⁶ Phemister, D. B., and Gordon, G. E. The Etiology of Solitary Bone Cysts. *Journal of American Medical Assn*, vol. lxxvii, p. 1429, October 20, 1920.
- ⁷ Rose and Carless. *A Manual of Surgery*—10th Edition, page 674. J. F. Hartz Co., Toronto, 1920.

TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held February 7, 1927

The President, DR CHARLES F MITCHELL, in the Chair

BONE TRANSPLANTATION FOR SPONDYLOLISTHESIS

DR A BRUCE GILL presented three cases of spondylolisthesis which had been operated on by bone transplantation to fuse the three lower lumbar vertebræ with the sacrum

DOCTOR GILL also presented a series of lantern slides illustrating Osteochondritis of the hip (Legg's disease) Osgood-Schlatter's disease of the tubercle of the tibia Koehler's disease of the tarsal scaphoid Freiberg's disease of the head of the second metatarsal bone Displacement of the epiphysis of the head of the femur during adolescence Osteochondritis of the bodies of the vertebræ Apophysitis of the heel

OSTEOCHONDRITIS OF HIP

DR E L ELIASON reported the history of a girl, aged eleven, who early in July, 1926, without apparent injury, began to limp but without pain She continued to limp for six weeks, at which time an X-ray was made and reported negative She continued to limp until December 23, when, following a slip on the ice, she was unable to rise due to disability in her left leg On admission to the hospital, December 28, 1926, an X-ray revealed an epiphyseal separation at the upper end of the femur Examination of her previous X-ray taken in August, disclosed the fact that a slight slipping of the epiphysis could be noted at that time Fluoroscopic reduction was obtained and the limb placed in a Whitman abduction case in which it was kept for five weeks At this time it was removed and an X-ray taken which showed perfect reduction but also a rarefaction of the upper end of the diaphyseal fragment This patient ran a persistent fever of from 99 to 99.2 or 99.3 during her stay in bed Her leucocytes were between 10,000 and 11,000 Diagnosis Osteochondritis with complete separation of the epiphysis Patient is still in hospital

DOCTOR ELIASON gave the history of a second child, a boy aged thirteen, who was well until a month ago, when he was struck on the left hip by himself with a hammer while doing some nailing Following this he had some pain but was able to walk without limping A few days later he began to limp and continued to do so up until about two weeks before his present accident, which occurred October 10, 1926 On this date while walking along on the level ground, the patient's left leg rotated itself externally and he fell to the ground backwards He was picked up and helped home being unable to stand on this leg He was admitted to the hospital eight days after his accident at which time X-ray revealed an epiphyseal separation at the upper end of the femur Reduction was accomplished under the fluoroscope and the limb dressed in a Whitman case Throughout the patient's stay in the hospital he ran a slight temperature—average 99 A leucocyte count was

not made At the end of seven weeks the case was removed and an X-ray showed a perfect reduction and union, there being, however, some rarefaction and absorption on the upper end of the diaphysis The radiologist states that at this time he cannot be sure whether this rarefaction is due to the injury and disuse or some preexisting disease Diagnosis Osteochondritis with complete separation of the epiphysis

Patient has completely recovered but is still under observation

DR W G ELMER said that he had at present a child of fourteen years, who fell while roller skating last September She was treated in the general surgical service of one of our large hospitals for an intracapsular fracture of the hip, by means of an abduction plaster case from the ankle to the waist The child still limps and has some pain when she walks without a crutch The X-ray shows no union and the head of the femur is pushed down on the neck There is shortening of approximately one inch Intracapsular fracture of the hip is very unusual in a child If the bone had been normal there should have been solid union in five weeks if the fragments had been in good position and the X-ray taken at the time the case was applied showed that they were in good position There was evidently some fault in the texture of the bone and this case should be classed as osteochondritis deformans juvenilis or Legg's disease The speaker does not favor bone pegging in these cases as the bone is of poor quality to start with Abduction in plaster and protection from weight-bearing for six months is his method of treatment

Another patient, a boy of seventeen years, was hurt in a foot-ball game, but continued in the game and continued playing during the remainder of the season, although he walked with a limp He had been having chiropractic treatments from the autumn of 1924 to the autumn of 1925 His physician then had an X-ray examination made and also an examination by a surgeon and the diagnosis then made was tuberculosis of the hip When first seen by Doctor Elmer in January, 1926, there was no muscle spasm, the hip moving freely in all directions, but with range of motion somewhat limited, and there was one-half inch shortening The epiphysis was separated from and pushed down on the neck of the femur A diagnosis of Legg's or Perthe's disease was made A good result was obtained in this case after treatment over one year

POST-OPERATIVE STRICTURE OF THE COMMON BILE-DUCT

DR EDWARD J KLOPP said that accidental injury of the common bile-duct with the resulting biliary fistula or stenosis and the evolution of the methods devised for the correction of these sequels are well known to most surgeons of experience Fistula and stenosis occasionally follow purposive operations upon the common duct when there has been no error in technic Obstruction may be avoided by burying a catheter in the duct extending into the duodenum as recommended by Duval and Richard Their method is comparatively simple and should receive serious thought when drainage of the common duct is desired in the absence of infection The T or fishtail tube is used because it is practical and easily introduced In many cases a large amount of bile leaks around the tube It may do no harm in the majority of cases but we cannot deny that it has caused serious damage

The use of the buried catheter in reconstructing the common bile-duct as suggested by McArthur has given him and others gratifying results He

POST-OPERATIVE STRICTURE OF THE COMMON BILE-DUCT

recommends leaving the catheter long so that the intestinal tug will cause it to be discharged through the bowel after the duct has been repaired and epithelialized, and before there has been bile deposit about the tube to again produce obstruction. Short tubes may remain for an indefinite period and act as a nidus for deposit of bile salts.

Various plastic operations have been performed on the ducts many of which met with success. Eliot wrote a splendid paper in 1918 reporting three of his own cases and abstracting many cases from the literature and personal communications. It gives one a comprehensive idea of the various methods employed in plastic surgery of the biliary apparatus. The more recent paper by Walters adds valuable information regarding this work.

Needless to state that most of the cases reported have been dealt with satisfactorily. It is regrettable that more failures have not been reported. The Van den Burgh test has been a great aid in selecting a comparatively safe time when one might undertake to correct a stricture

of the common duct. In the absence of fistula and the increase of bile pigment in the blood, it has been suggested that a fistula be established and correction of the stricture be done at a second operation. These cases are not select operative risks, the operation is time-consuming on account of adhesions and generally the absence of the gall-bladder as a guide. The following case is reported because of several impressive facts:

- 1 The common duct was injured while removing a gall-bladder that was not badly diseased.

- 2 The use of the fishtail tube in the first reconstructive operation was followed by stricture within six months.

- 3 Introduction of the buried catheter through the papilla of Vater and sphincter of Oddi was accomplished with considerable difficulty at the second reconstructive operation, due to the large size catheter.

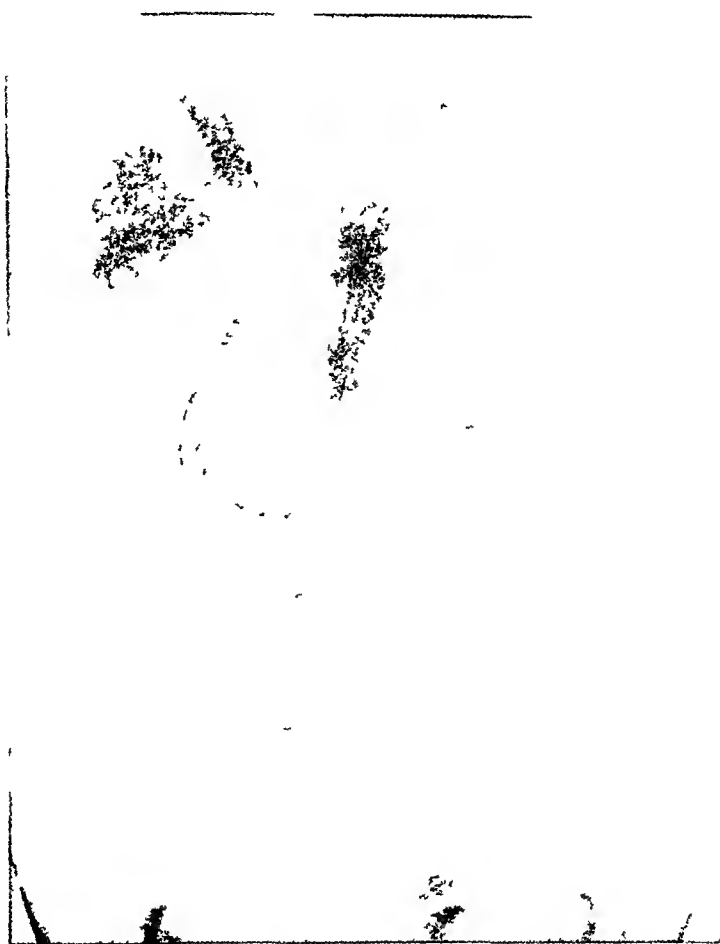


FIG. 1.—Showing part of a No. 24 French Catheter which has been in the repaired common duct and the duodenum for ten months. The patient is practically free from symptoms.

4 The patient has worn the catheter for approximately ten months with little discomfort. One is amazed at the tolerance of the duct and the duodenum. We think the catheter should be removed through the intestine, probably jejunum. The patient declines interference so long as he is comfortable. It is feared that there will be a deposit of bile and subsequent obstruction.

A man, aged thirty-six, referred to Doctor Gibbon's service, Jefferson Hospital, by Doctor Immeiman of the Gastro-enterological Department, August 24, 1925. The gall-bladder and appendix were removed elsewhere on April 4, 1925, for symptoms referable to the stomach and intestines with pain radiating under his right shoulder and back. Two drains were inserted. Three days later one drain was removed which was followed by profuse drainage of bile. Three weeks after the operation re-suture of the wound was attempted. There was profuse drainage of bile until six weeks before admission to Jefferson.

On admission there was marked jaundice with all the usual phenomena. There was a large fluctuating mass bulging in the region of the old scar. This was opened by the resident who obtained 1000 cc of bile. The jaundice faded, bile drained freely through the fistulous opening and the direct Van den Burgh was negative three weeks later.

On September 18, 1925, under ether anaesthesia, we injected the fistulous tract with methylene blue and excised the old abdominal scar and fistula. An obstructing scar 1 cm long in the mid-portion of the common duct was partially excised and a fishtail tube inserted in the usual manner. A Penrose drain was placed along the side of the tube. Bile immediately drained through the tube, on the eighth day there was free drainage external to the tube. On the fourteenth day the tube came out. He was discharged, wound healed, no jaundice, digestion good, bowels satisfactory, on October 29, 1925.

He was symptom-free until March 1, 1926, when jaundice reappeared with the associated symptoms. Wound remained closed, no swelling of abdomen. He returned to the hospital, March 8, 1926, was transferred to the Pennsylvania Hospital, March 21, 1926, where I was then active. After careful preparation he was again operated upon April 12, 1926, under ether anaesthesia. The scar in the duct was 2 cm long extending to the duodenum. It was excised. After dilating the papilla and sphincter of Oddi a No. 10 soft rubber catheter passed into the duodenum. We were desirous to bury a large catheter, having failed previously to prevent stricture. The duodenum was opened and more dilating was done with suitable instruments. It seemed as if a No. 24 catheter, the size we decided to use, should pass. We were unable to grasp the tip of the catheter through the sphincter with a duct stone forceps. The No. 10 catheter was introduced through the distal portion of the duct into the duodenum. The eye-end of the larger catheter was sutured in the funnel-end of the smaller and by pulling on it through the artificial duodenal opening and pushing on the larger from above it was put in position with comparative ease. A suitable mandrin was not at hand. The funnel extended upward into the dilated portion of the duct. It was impossible to make a satisfactory anastomosis of the duct. The defect was covered with omental tissue.

About 10 cm of the distal end of the catheter was cut off. It was thought that too much catheter of large calibre in the small intestine might be very uncomfortable. I now think that this was an error. The duodenal wound was closed. A Penrose drain was carried to the site of duct anastomosis.

Bile drained externally for three weeks. There has been no drainage since. The scar is satisfactory, there is no evidence of hernia.

DR JOHN B. DEEVER said that with the patient he agreed that it is better to continue to wear the tube. Doctor Deever has had the tube remain as long as eighteen months, and then be passed. The tugging probably has little to do with this. One patient wore a T-tube for four years. The most satisfactory operation when feasible is anastomosis of the proximal end of the common duct to the duodenum. This is not a difficult operation and offers excellent results. However, it was not possible for Doctor Klopp to do this in this case. It sometimes requires two or three operations to secure a result in this type of case with always a chance of subsequent stricture.

PRIMARY ULCER OF THE JEJUNUM

DR I. S. RAVDIN read a paper with the above title, for which see page 873.

ACUTE INTESTINAL OBSTRUCTION

DR J. STEWART RODMAN reported three cases which had occurred during the past year in his service at the Bryn Mawr Hospital. In each case the cause of the obstruction was sufficiently unusual to warrant placing it on record.

CASE I—A woman, age fifty, was admitted to the hospital, November 28, 1925, with the chief complaint of "pain in abdomen and vomiting." About twelve hours before admission she was suddenly seized with severe pain in the lower abdomen followed by nausea and vomiting. The pain at first was generalized throughout lower half of abdomen, later to become more localized about umbilicus. The bowels had moved the day before. Several enemas before admission had failed to give relief. The patient had had a cholecystectomy and vaginal repair eight years ago. The past history was otherwise negative. When admitted she was in acute abdominal distress. Palpation of abdomen revealed a suggestion of a mass on the right side of abdomen, although as she is quite stout, it was impossible, to be sure of this. Vaginal examination was negative for pelvic pathology. A diagnosis of acute intestinal obstruction due to adhesions from laparotomy was made. Operation revealed a large mass filling the entire right lower quadrant across middle line due to an enormously distended bowel. A puncture was made which immediately allowed a large quantity of gas to escape. The collapsed bowel was then easily delivered and as this was done the bowel was seen to rotate completely, relieving the obstruction above and below. The portion of bowel involved was the lower part of the ascending colon and cecum. The appendix was removed and the wound closed without drainage. The patient made an uneventful recovery, leaving the hospital three weeks later. This case was obviously one of torsion at two points, one in the ascending colon, another in the terminal ileum, completely isolating and obstructing the intervening loop of bowel. A cursory review of the literature for the past ten years has failed to reveal another case of torsion at two different points of the bowel isolating and distending a loop as in this case. Acute obstruction due to torsion at a single point is, as would be expected, a fairly common occurrence.

CASE II—A man age sixty-eight was admitted to the hospital November 4, 1925, with chief complaint of "obstruction of the bowel." Six days before admission he had been suddenly seized with severe pain in the lower

left quadrant of abdomen and vomited. Morphia relieved the pain partially. On the fourth day after the onset of the illness the pain was suddenly and spontaneously relieved and the bowels moved. The pain returned the following day and enemas were ineffectual. No further vomiting occurred. The man had had a double inguinal hernia for the last twenty years for which he had worn a truss. On admission the temperature was 99.3, pulse 80, respiration 20. He was apparently in pain. The abdomen was moderately distended, resistant and somewhat tender on the left lower quadrant. No definite tumor mass was found in left inguinal canal, although the overlying tissues somewhat swollen and tender. There was a reducible hernia on the right side. Under local anæsthesia the left inguinal canal was opened. No hernia was found but a thickened and œdematous spermatic cord which traced to the internal ring disclosed a mass apparently adherent to the ring within the abdomen. The incision was enlarged upward, opening the abdomen, and a loop of small intestine found adherent to the parietal peritoneum. No attempt was made at that time to dislodge the mass, but a Paul's tube was inserted into a loop of bowel proximal to the mass. The patient made a relatively smooth recovery from the operation but two subsequent attempts to close the fecal fistula have been unsuccessful. Ileosigmoidostomy was performed nineteen days after the first operation and inversion of the fistula was made six weeks later. In spite of daily evacuations by rectum the fistula continued to drain.

Reduction of strangulated hernias *en masse* happens every now and then, but in the reported cases has always been the result of taxis. The unusual feature of this case was that no taxis was used but large and repeated doses of morphia given.

CASE III.—A man, age fifty-five, was admitted to the Bryn Mawr Hospital, January 18, 1926, with the chief complaint of pain in the abdomen. On the previous day the patient had been seized with pain in the left lower quadrant and took paregoric for relief. The pain continued on the following day, gradually increasing in severity. Vomiting occurring once. The bowels have been more or less constipated for some time, but moved slightly twenty-four hours before admission, on the second day of the illness. The patient had been in good health save that one week prior to admission he was run over by a wagon, sustaining contusions of both legs. On examination the abdomen was slightly distended and tender in lower left quadrant and there was rigidity of the left rectus. Peristalsis was about normal. No masses were felt. Temperature 98.2, pulse 60, respiration 20. At operation, the evening of admission, the intestines were found to be filled but no free fluid was present. A small mass was felt within the abdomen adherent to parietal peritoneum over the sigmoid. On further exposure the mass proved to be sigmoid somewhat kinked and adherent to parietal peritoneum by an inflammatory mass in its wall. Gentle manipulation loosened the mass from the parietal peritoneum, upon which, the sigmoid resumed its normal position. As the mass was small and did not then encroach upon the lumen of the bowel, it was not disturbed. Convalescence was uneventful except for a surgical wound infection. W. J. Mayo (*Journal American Medical Association*, September 8, 1917), in 1907 reported with Adson and Griffin five cases, of diverticulitis of the sigmoid, the first in which the pathology was established during life—since has resected bowel for diverticulosis in 42 cases—in 36 sigmoid, one transverse colon, in one the hepatic flexure and cæcum, in one the rectosigmoid juncture and in two the rectum, all acquired symptoms suggestive of acute appendicitis on left side. Mayo recognizes four types. I Self limiting Diverticulitis and Peridiverticulitis. II Diverticulitis

MESENTERIC CYSTS

and Peridiverticulitis with abscess resulting in Fistulae III Obstruction (31 per cent malignant disease coexists) Obstruction not quite complete therein differing from carcinoma It is sometimes necessary to do colostomy or temporary ileostomy IV Carcinoma developing on a Diverticulum

Of 42 cases operated up to time of report, 14 per cent died as a result of operation

J T Rogers (*Minnesota Medicine*, January, 1923) believes the surgical treatment in any given case must depend upon the severity of the symptoms the condition of the patient, and the judgment of the operating surgeon From his own experience and a careful review of many cases reported, he is convinced that simple drainage in most cases will be followed by cure In three cases resection seemed necessary but drainage resulted in cure

The incidence of diverticulitis of the large bowel is set forth by J W Larimore (*Journal Missouri State Medical Association*, April, 1925) in 4408 X-ray examinations he found 55 times (1.24 per cent) In 21 cases there were isolated diverticula, 34 cases showed multiple diverticula The sigmoid was the most frequently involved portion of bowel

DR WALTER G ELMER recalled a patient who had complete obstruction for one week A long median incision was made and instantly the large intestine protruded from the wound and became distended to the size of a child's balloon and seemed to be on the point of rupturing It was opened to relieve the tension and closed at once Apparently the transverse colon had been hanging down in the abdomen and a long loop had apparently twisted on itself Reversal of the colon immediately relieved the obstruction The operation was completed by colostomy and the patient made an uneventful recovery The colostomy will be closed subsequently by a plastic operation

MESENTERIC CYSTS

DR WILLIAM B SWARTLEY read a paper with the above title, for which see page 886

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY AND THE PHILADELPHIA ACADEMY OF SURGERY

Joint Meeting Held February 9, 1927

DR WALTON MARTIN in the Chair

CIRRHOSIS OF LIVER, OMENTOPEXY, SPLENECTOMY

DR ALLAN O WHIPPLE presented a man, thirty-six years of age, who was admitted to the Presbyterian Hospital of New York, August 24, 1920, on account of copious hæmatemesis. His history was essentially negative. He had never had any pain or discomfort after meals. He had noted that at times during the past year, his stools had been dark, had been subject to frequent nose bleeds. Two months ago when apparently in perfectly normal health, he experienced sharp pain referred to the middle of the abdomen which disappeared after a few minutes. During the following night, he began to vomit food mixed with blood, the vomiting recurred at frequent intervals for a period of some hours when it ceased. There was no pain. He remained in bed thereafter for a period of ten days when he felt as well as ever. Three days before admission he was awakened from a sound sleep by nausea and vomiting. The vomitus was chiefly dark blood, was about one-half pint in amount. Soon after he also passed a black stool. Following this, his hemorrhage ceased, leaving marked weakness. When he was admitted, his general physical examination was essentially negative save for anæmia, the abdominal examination revealed, in the left upper quadrant, a palpable mass extending from the midline down to the level of the umbilicus not tender, smooth, firm, edge rounded, no notch made out. Red blood-cells, 3,300,000, hæmoglobin, 50 per cent, white blood-cells, 2000, polymorphonuclears, 63 per cent. Small lymphocytes, 26 per cent, large lymphocytes, 8 per cent, transitionals, 3. Clotting time seven minutes, bleeding time normal. Red cells showed central pallor, platelets slightly diminished in number. The attacks of blood vomiting continued on account of which he was given three transfusions. At time of operation, the red blood count was 2,400,000, hæmoglobin, 60 per cent. Ascites developed with rapidity, demanding two tappings previous to operation.

At operation the peritoneum contained from three to five litres of straw-colored fluid, liver was cirrhotic, spleen was enlarged eight to nine times normal size, spleen was removed and a tongue of the omentum, 10 cm long, was drawn out through the upper angle of the wound and fastened in the cleft formed by the split rectus fibres. Spleen, after removal, weighed 6 kilos, microscopical section showed almost complete disappearance of Malpighian bodies.

Convalescence was complicated by a right lower lobe pneumonia. Later he developed a thrombo-phlebitis of brachial vein. He gained markedly in weight, there was no re-accumulation of ascitic fluid. When discharged, red blood-cells were 4,500,000, hæmoglobin, 90 per cent. Now, over six years after operation, he remains well, has had no recurrence of ascites, no vomiting of blood, no gastro-intestinal disturbance of any sort, bowels regular, general health perfect. Red blood-cells, 5,000,000, hæmoglobin, 85 per cent, white blood-cells, 7300, platelets, 350,000. Scar linear and firm, no hernia, no ascitic fluid, liver edge not palpable and on percussion, liver would seem to be somewhat smaller than normal.

DR T TURNER THOMAS (of Philadelphia) said that in the Philadelphia General Hospital, in which the percentage of indigent alcoholics is very high, he had been able to find brief records of four cases in which he had resorted to omentopexy

DOCTOR THOMAS had undertaken the operation in each case with little expectation of benefit and as the result of his experience had not been able to develop any enthusiasm for it. The greatly lowered vital resistance of the patients, the usual advanced cardio-renal disease, absence of sufficient functioning of the liver and sometimes other grave complications, make the prospects for long-continued benefit doubtful. Except in one case which died thirty-two days after operation, the early results of the operation were distinctly encouraging, but death was not long delayed by it. The combination with splenectomy as done by Doctor Whipple may so change the results as to increase his confidence in the operation

His first case was operated upon August 17, 1908. In this case, after the abdomen had been opened, the peritoneal surfaces were rubbed with gauze and the omentum was sewed to the anterior parietal peritoneum. The abdominal wound was closed without drainage, leaving a suprapubic opening for drainage to pelvis. The patient was discharged two months and two weeks after operation. During the subsequent year he was readmitted and discharged several times and finally died one year and twenty-three days after operation, still had ascites

The second case was admitted to Philadelphia General Hospital, April 29, 1919. In February, 1919, without apparent cause, his abdomen began to swell. Getting no relief he came to Philadelphia General Hospital as above stated, about two months after beginning of swelling. From then to October 22, 1919, date of operation, he was tapped seventeen times at intervals of from four to twenty-three days, a total of fifty gallons being removed. Urine examined twelve times and showed a few hyaline and granular casts, a trace of albumin and occasional leucocytes

Operation—The adjacent surfaces of the diaphragm and anterior abdominal wall, liver and spleen were rubbed with gauze, the omentum at the upper part sewed to the anterior abdominal wall, and lower part in the abdominal incision. Rubber drainage tube to bottom of pelvis through suprapubic stab wound. Sutures removed November 12, and patient transferred to Medical Department, December 23, and after a short stay discharged. He was readmitted March 1, 1920, and transferred to the almshouse, where he died June 27, 1920 eight months after operation. Could obtain no record of cause of death or of condition preceding it

The third case was admitted to Philadelphia General Hospital, November 22, 1923. She was a woman, thirty-four years old, and a chronic alcoholic, diagnosis mitral regurgitation, hepatic cirrhosis, with marked ascites (tapped many times), chronic nephritis

Under date of December 16, 1923, the following note was made. Repeated abdominal tapplings have failed to check the transudation of fluid into the abdominal cavity. The portal obstruction must be extreme, for at times the patient passes blood by the rectum

December 24, 1923, under spinal anæsthesia a midline incision was made and a great quantity of straw-colored fluid evacuated. The liver was found to be atrophic and firm, but not nodular. The peritoneal surfaces of the liver

and spleen, stomach and intestines were rubbed with dry gauze, as well as the corresponding surfaces of the abdominal wall and diaphragm to induce the later development of inflammations and adhesions. The omentum was sutured to the peritoneum of the anterior abdominal wall as widely as possible. A suprapubic stab wound was made below the inferior margin of the operation incision and a rubber drainage tube inserted to the depth of Douglas' Pouch.

January 16, 1924, paracentesis yielded 4000 c c of greenish, turbid, frothy fluid.

January 23, 1924, abdomen tympanitic. Dulness in flanks. Peristalsis abnormally active in upper abdomen. Diminished in lower abdomen.

January 25, 1924, died, thirty-two days after operation. Autopsy showed fibrinous, purulent peritonitis and intestinal obstruction. Clinically the signs were of mechanical intestinal obstruction.

The fourth case was admitted to Philadelphia General Hospital, September 16, 1925, complaining of weakness and swelling of the abdomen and lower extremities of about three months' duration. He is fifty-six years old and has been a laborer working in and about breweries and saloons. He says he has been a heavy drinker all his life, but was perfectly well until about three months before admission when he first became aware of a gradual swelling of the abdomen and weakness without other symptoms. A physician tapped his abdomen, obtaining a "medium-sized bucketful." He was soon admitted to another hospital, but did not stay longer than a week, his abdomen being tapped there twice, each time about a bucketful being taken out. The swelling of the abdomen has been progressive during the four weeks preceding admission to the Philadelphia General Hospital, the legs and scrotum participating to a very marked degree. He says he was never ill before, never vomits except after excessive indulgence in alcohol. He has averaged a half pint of whiskey a day for the past ten years. He weighed 180 pounds three months ago, since when he lost twenty pounds. Is not now acutely ill but very uncomfortable from the abdominal swelling and cedema of the legs and scrotum and the dyspnoea. He has the characteristic alcoholic facies, but while his heart sounds are impaired in quality it is regular and has no murmurs and his lungs are in good condition. There are distended abdominal veins and ascites present but no gastro-intestinal symptoms except loss of appetite. Repeated examinations of his urine have shown not more than a faint trace of albumin and no casts. On September 18, seven litres of fluid were withdrawn from abdomen, but on September 25, only a small quantity probably because of the shortness of the canula, although on the following day the site of the tapping drained profusely. October 15, forty ounces were withdrawn and on the following day he was transferred to the Surgical Ward. Blood Wassermann, negative. Urine specific gravity 1020, faint trace of albumin, no casts and no red blood-cells.

Operation—October 30, 1925. A median incision is made about eight inches long from about two inches below the umbilicus upward. On opening the abdomen only a moderate quantity of fluid escapes, but more is soaked up and removed by gauze pads. The liver is contracted and hardened. The upper surface of the liver and the adjacent diaphragmatic surface is rubbed vigorously with gauze on both sides of the falciform ligament. In like manner the surfaces of the stomach, intestines, spleen and to a less degree the omentum, with the corresponding parietal peritoneum, are irritated. The omentum is then sutured to the anterior abdominal wall by three catgut sutures as far out as can be reached, the lower part of the omentum being

left free to be brought outside the peritoneum where it is sutured between the recti muscles, the margins of the divided linea alba being sutured together over it, after the peritoneal margins are closed around the protruding omentum. In the preceding cases a suprapubic drain was introduced into the bottom of the pelvis, but is omitted in this case because of the small quantity of fluid withdrawn by tapping and during the operation.

December 2, although the abdomen is moderately distended, free fluid cannot be demonstrated. There is now no edema of the abdominal wall, scrotum or extremities, although he has been out of bed walking about or sitting down about eight and one-half hours. He says he has no shortness of breath, no feeling of weakness and experiences no difficulty in going up or down stairs. His face has lost the somewhat shiny redness and puffiness which was present before operation and is slightly wrinkled and hollow. He is very anxious to be discharged in order to go to work which he says he is as fully able to do as before his troubles began about three months before admission. He admits a strong desire for something to drink. He was discharged December 4, 1925. Six weeks later he was readmitted to Medical Ward on account of renewed swelling of abdomen and dyspnea. Admits having been drinking steadily since discharge one month ago. The day after his admission eight quarts of fluid were withdrawn by trocar. He died January 27, 1926, twelve days after admission and almost three months after operation.

DR JOHN SPEESE (of Philadelphia) said that the addition of an omentopexy in the treatment of Doctor Whipple's case might cause some confusion that it had been used by him as a measure of further diverting blood from the liver in an advanced case of Banti's disease, whereas Doctor Thomas was alluding to an entirely different group of cases, *i. e.*, portal obstruction from cirrhosis of the liver. The improvement in the patient's condition must have been due to the splenectomy which is now regarded as the operation of choice and if these cases of splenic anemia are operated upon early in their development, a cure should be obtained by removal of the spleen in a very high percentage. Unfortunately the majority of them come to the surgeon in a late stage, but even with adhesions between the spleen and the surrounding parts, with fibrotic changes in the liver and ascites removal of the spleen is followed by pronounced improvement in many instances and the hemorrhages occasionally encountered, are almost immediately checked.

DR WILLY MEYER (of New York) called attention to the eventual benefit to be derived from the use of superheated air treatment, when the omentum had been placed subcutaneously. Last winter he showed a patient before this Society, who had been operated on in 1911 for carcinoma of the rectum which was excised. He returned in 1924 with pronounced ascites. Tapping was done, but the liver was not palpable and not enlarged. X-rays seemed to indicate a possible malignancy of the stomach, and therefore exploratory laparotomy was done without finding any pathology in the stomach. The liver was seen to be rather reduced in size and in a condition of chronic inflammation, the patient was neither alcoholic nor syphilitic. As there was no secondary tumor, omentopexy was clearly indicated and carried out by placing a portion of the omentum in a pocket below the skin. Three weeks

later the patient had to be tapped once more, but subsequently made an uninterrupted recovery under the daily prolonged use of superheated air, which was continued at home for many months. It was observed that the ascites receded from week to week. This was two years ago and the man has remained perfectly well. Judging from this experience the simple method deserves to be tried in similar cases.

DR A. P. C. ASHURST (of Philadelphia) said that he believed the splenectomy had more to do with effecting a cure in Doctor Whipple's case of Banti's disease than the omentopexy. Portal obstruction does not cause ascites, it causes gastro-intestinal hemorrhages, and many years ago Rolleston had pointed out that patients with uncomplicated cirrhosis of the liver never lived long enough to require more than one tapping. The patients who survive many tapings have something else than cirrhosis; they have a polyserositis, or they are cases of Banti's disease. It will be noted that the only case in Doctor Thomas' series in which omentopexy was of benefit had hemorrhage from the intestines before operation. The speaker thought one should restrict omentopexy to patients with hemorrhage and in cases of ascites merely take out the spleen, if Banti's disease seemed to be the cause, or attempt to relieve the abdominal serositis by gauze friction over the liver and spleen.

RUPTURED ANEURISM OF FEMORAL ARTERY

DR ALLAN O. WHIPPLE presented a man, twenty years of age, who was admitted to the Presbyterian Hospital of New York, June 6, 1926, on account of painful swelling of the left thigh. Previous history negative, except for initial lesion of lues four years ago. Five months ago, he first noted a swelling of the left mid-thigh which has gradually increased in size until now it measures the size of an infant's head. Pain has steadily increased in it and has been extreme during past month. Swelling occupies lower two-thirds of left thigh. It is diffuse, fluctuant, hot and tender. There is no definite evidence of any expansile pulsation, although there was a slight bruit. Entire lower leg is oedematous, X-ray shows periosteal proliferation of lower third of femur probably of luetic origin. Red blood-cells, 2,300,000, hæmoglobin, 40 per cent, white blood-cells, 22,800, polymorphonuclears, 88 per cent. Wassermann positive. A transfusion of 700 c.c. of blood was made, after which the red blood-cells rose to 2,800,000, hæmoglobin, 50 per cent.

Operation, under spinal anaesthesia, was begun by incision over Scarpa's triangle. This opened a cavity from which a sudden gush of old broken-down blood together with fresh blood took place. Left femoral vessels were ligated at once. This controlled the bleeding. On sponging the cavity, there was a sudden release of pus. Amputation was then performed below the trochanters. Patient stood operation well, but because of his anaemia, another transfusion was given after the operation. Cultures of pus showed pure growth of hæmolytic streptococcus. Dissection of the amputated extremity revealed a funnel-shaped enlargement of the femoral artery beginning 7 cm. below the level of the distal end of the femur. This was continuous with an aneurismal wall which had ruptured and become indistinguishable from the surrounding soft parts. Both ends of the funnel-shaped enlargement opened directly into the broken-down tissue of the soft parts. The middle third of the femur showed areas of thickened periosteum and in other areas eroded bone. The operation wound was Dakinized. Pulse and

DIVERTICULUM OF THE BLADDER

temperature rapidly returned to normal. Pain immediately relieved, general condition improved rapidly from day to day. Further healing without complication.

DR HUBLEY R. OWEN (of Philadelphia) said he had a case similar to Doctor Whipple's in his ward at the Philadelphia General Hospital some fourteen years ago. The patient was an elderly woman who on admission had a large inflammatory tender fluctuating mass in the upper third of the left thigh. As the patient was in considerable pain on her admission in the evening, the Resident Physician ordered the patient taken to the Women's Dressing Room and, after freezing the area with ethyl chloride, opened into the supposed abscess. The mass proved to be a dissected aneurism of the femoral artery. The tissues superimposed upon this aneurism were infected and considerable pus was evacuated before the aneurism was reached. The patient had a massive hemorrhage. The Resident Physician applied a tourniquet and when Doctor Owen was called it was necessary to do an immediate amputation. It was impossible to control all the bleeding about the aneurism. The patient never recovered from the shock of the operation and died a few hours later.

DIVERTICULUM OF THE BLADDER

DR EDWIN BEER said that it is surprising that diverticulosis of the hollow organs has been recognized as a frequent occurrence only during the last twenty-five years. Diverticulum of the œsophagus and Meckel's diverticulum of the small intestine have been recognized for many years, on the other hand, diverticula of the intestine up to 1904 was scarcely appreciated as a clinical entity. In that year he was able to collect in his original paper on "Intestinal Diverticula" only eighteen cases from the whole literature of the preceding half-century. Nowadays, however, the condition is well known as a clinical entity, and hundreds—if not thousands—of cases of this disease have been recognized by the profession and the condition is regularly considered in the diagnosis of intestinal cases. Diverticula of the bladder have fared even worse than diverticula of the intestine, and it is only during the last fifteen years that numerous observers have been studying this condition and removing diverticula of the bladder by surgical procedures. Cystoscopy and cystography have opened this field to surgical therapy.

DOCTOR BEER then demonstrated a series of diverticula in lantern slides. Some of these diverticula of the bladder are enormous—one case having held as much as twenty-six ounces of residual urine. That they are probably congenital in a great many cases is evident from the fact that numerous cases have been discovered in children—one even in the first year of life. The presence of these diverticula leads to difficulty in emptying the bladder, and frequently a secondary dilatation of the ureter and hydronephrosis. Some of them are associated with obstructions at the neck of the bladder, and in prostatic or patients with contracture of the bladder neck, diverticula are liable to develop. The orifices are seen as a more or less dark hole cystoscopically, but the exact size of the pouch can only be determined by filling

it with an opaque fluid and taking X-ray pictures antero-posteriorly and laterally. Complications set in when these diverticula are infected and, occasionally stones form in these diverticula and have to be removed with the diverticulum. Occasionally, some of these stones project into the bladder as collar-button or dumb-bell stones filling the diverticulum and presenting as a mushroom growth within the bladder lumen. If the stone is left in the diverticulum, the stone extension into the bladder is regularly liable to reform so that the patient will get recurrent vesical calculi. In other cases, tumors

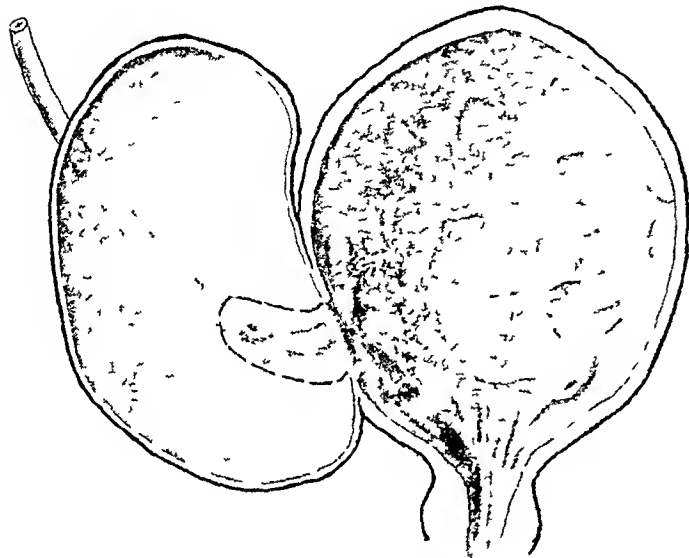


FIG. 1.—Diverticulum of bladder with ureter emptying into diverticulum. Triangular flap of diverticular wall outlined, the rest of diverticulum cut away.

form in the diverticulum, which present a group of cases that are most difficult to treat satisfactorily. With infection, peri-diverticulitis sets in and the pouch becomes firmly adherent to all the pelvic structures so that removal becomes a most difficult and arduous undertaking. In some cases the ureter empties into the diverticulum at some distance from the bladder, and various methods for caring for ureter were developed.

The case about to be presented, shows a new method for caring for such a ureter which emptied into a diverticulum one and one-half inches from the bladder. The presence of one of these infected diverticula leads to very slow healing of the suprapubic wound, and occasionally in prostatectomies, one is forced to go in secondarily to get a closure of the suprapubic wound by the removal of the infected diverticulum. It is interesting to note that in the series of cases numbering well over two dozen that have come to operation in his experience, none of the diverticula have been seen in the female sex.

DOCTOR BEER then presented a man, sixty-six years old, who was admitted to Mt. Sinai Hospital, September 16, 1926, having been troubled with great urinary frequency for some time. At times overflow, at present, apparently, completely obstructed. Immediate suprapubic drainage operation was done, and after patient's blood chemistry had dropped, the second-stage removal of a small fibrous prostate was accomplished. No cystoscopy was done before operation. The patient's suprapubic wound, despite all attempts to encourage healing, failed to heal completely. It would regularly break down after being closed for a short time. His residual urine continued after operation around twelve ounces.

A cystogram was taken, and a large diverticulum was found on the right side of his bladder. Cystoscopy showed that this diverticulum was in the region of the right ureter orifice, its opening was about the size of a dime.

DIVERTICULUM OF THE BLADDER

The left ureter secreted good blue, whereas no right ureter orifice could be seen. It was concluded from the cystoscopy that the right ureter emptied into the diverticulum.

January 7, 1927. A very adherent large diverticulum was excised, and it was found that the right ureter entered this diverticulum about one and one-half inches from the bladder. The ureter was left attached to a triangular flap, the rest of the diverticulum being excised, and the apex of the triangle

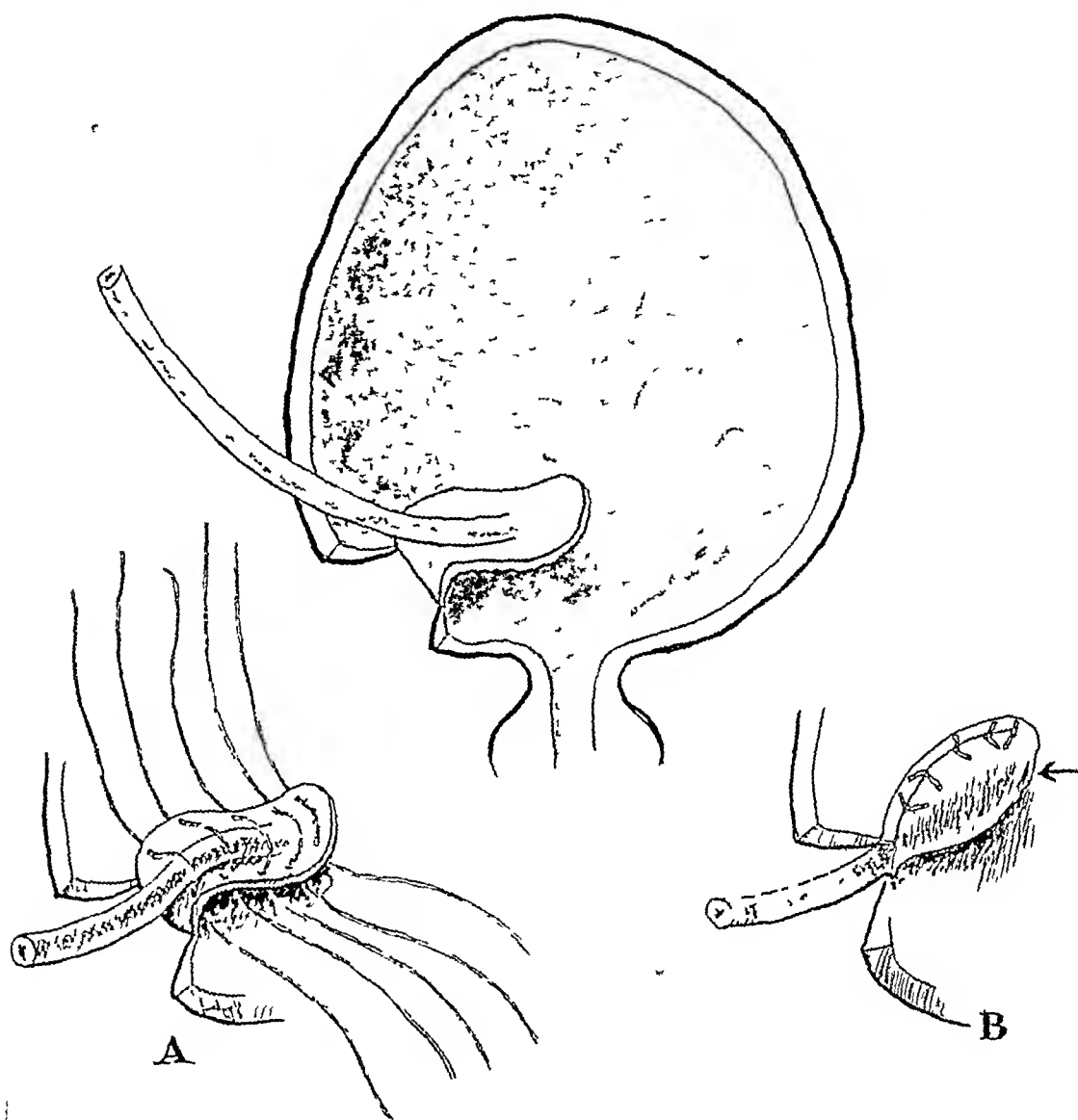


FIG. 2.—Illustrates steps by which right ureter was implanted into bladder and covered with diverticular wall.

was then drawn into the bladder and the mucous membrane of the diverticulum sewed over the ureter which now projected into the bladder. The orifice of the diverticulum was closed by several chromic gut infolding stitches applied to the outer wall of the bladder. The ureter catheter was passed up the right ureter at completion of operation to make sure that there was no stenosis caused by the plastic operation.

The patient's recovery has been uneventful, and with an indwelling catheter, his suprapubic wound has closed almost completely, or completely, so that patient is almost ready to be discharged from the hospital.

DR LEON HERMAN (of Philadelphia) said that in the surgical treatment of bladder diverticula excision of the sac is undoubtedly the method of choice but the best means of its accomplishment differs in different cases. There are two types which present unusual difficulties, namely, those in which the ureter opens into the sac, and those in which the sac springs from the inferior wall of the bladder in close approximation to one or the other ureter. In the surgical treatment of the first type, such as that presented by Doctor Beer, it is necessary either to sever the ureter and transplant it to another part of the bladder, to ligate it, thus destroying the kidney on the involved side, or to dissect out a flap of the diverticular sac containing the ureteral opening, and, in some way, implant this into the bladder. In following the latter procedure, the method of Young has been used, in which part of the sac containing the ureteral opening is employed to close the defect in the bladder wall. This method has the inherent disadvantage of employing defective tissue, and, in one of our cases, the procedure was followed by almost immediate recurrence of the diverticulum necessitating re-operation. In Doctor Beer's method the flap is carried into the bladder cavity and the closure of the defect accomplished by approximating the edges of the healthy bladder wall, the one point of weakness being at the point of entrance of the ureter. This ingenious method of Doctor Beer's appears to be a very practical contribution to surgical practice in dealing with diverticula containing the ureteral orifice.

DOCTOR BEER added that in removing diverticula of the bladder, the ease of the dissection varied with the degree of peri-diverticulitis. Doctor Young suggested some years ago a method of aspirating diverticula with suction applied over the diverticular opening within the bladder. In small non-adherent pouches, which probably require very little treatment, this might be feasible, but in larger diverticula that cause symptoms usually associated with firm adhesions to the pelvic structures, this method could not be applied, and the suggestion to apply it in these cases was somewhat jocular. These latter diverticula are so firmly imbedded by peri-diverticular inflammation as a rule, that it requires the greatest muscular effort to pull and dissect the adherent sac from its intimate attachments to the pelvic connective tissue and fat.

PAPILLARY CARCINOMA OF KIDNEY PELVIS

DR EDWIN BEER presented a man, forty years of age, whose chief complaint was an intermittent hæmaturia, with practically no pain until recently when he experienced some pain in left lumbar region. His painless hæmaturia began a year before admission (May, 1925), lasted three weeks and was profuse. Then there was a quiescent period. Six months before admission he had another attack of hæmaturia, and during the following months prior to admission, he had fifteen to twenty more attacks, bleeding usually for a few days at a time. Of late he has had some pain in the left lumbar region which did not run downward but radiated toward shoulder, pain gradually became more accentuated but seems to have no relation to hæmaturia.

He entered the hospital in May, 1926, after his last attack of hæmaturia had ceased. Physical examination showed no costo-vertebral tenderness and no abdominal palpatory findings. Cystoscopy showed a normal bladder and

PAPILLARY CARCINOMA OF KIDNEY PELVIS

normal ureters, no obstruction in either ureters and no retention in either pelvis. It was impossible to induce bleeding in the left kidney pelvis, where it was thought the tumor was placed, by active to and fro manipulations of ureter catheter. The left kidney urea was 0.6 per cent, whereas the right was 2.0 per cent, microscopic urinalysis showed an occasional red cell on the left, and many on the right. Several pyelograms were made, one of which showed very definitely incomplete filling of the left kidney pelvis and calices giving the appearance of fluffiness as if the pelvis was more or less filled with a spongy mass, making diffuse irregular densities.

The patient returned in September, 1926, with the history that he had been bleeding for three weeks. Cystoscopy, while bleeding, showed blood came from left ureter, and none from right ureter. Moreover, at all levels in the left tract, bloody urine was obtained. At this examination, just in front of the left ureter meatus, a minute papilloma about the size of the head of an ordinary pin, was discovered which was probably an implant from the renal pelvic tumor. This was immediately destroyed with the high frequency current.

September 13, 1926. Nephro-ureterectomy was done with excision of wedge of bladder about left ureter meatus through a lumbar kidney incision in which the vascular pedicle was tied, combined with an extra-peritoneal left rectus incision, exposing the lower ureter and bladder. On exposing the left kidney, it was found to be normal in appearance, normal in size, and the pelvis felt as if it were moderately distended with a soft spongy mass. No tumor could be felt. The parenchyma was absolutely normal in consistency. On removing the specimen the kidney was opened, and on incising the pelvis a papillomatous tumor, which filled the pelvis, mushroomed out through a small incision as if it had been under considerable tension.

Pathological diagnosis and microscopic report was "papilloma of kidney pelvis with early malignant changes."

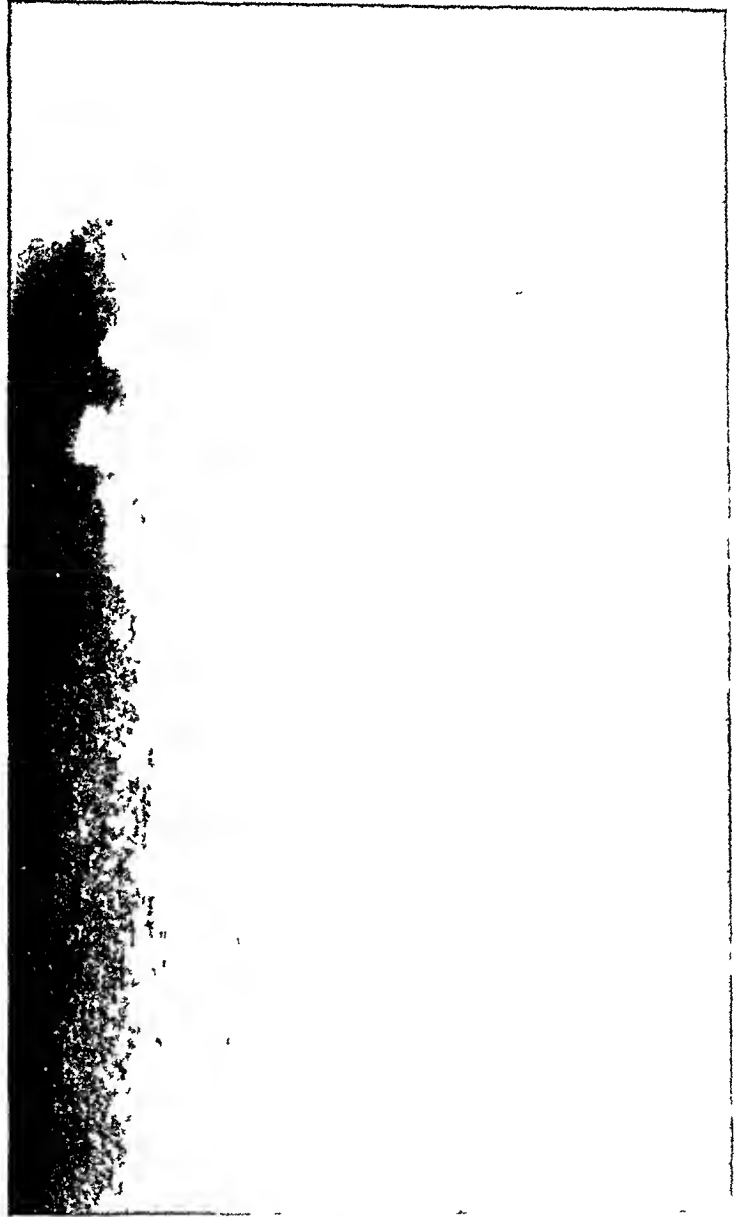


FIG. 3.—Pyelogram of papilloma of kidney pelvis. To bring out the delicate contrast shadows in the pelvis which was filled with a spongy papilloma, the original film had to be reversed and then printed.

TUMOR OF ACOUSTIC NERVE

DR A S TAYLOR presented an adult male who was admitted to Bellevue Hospital, December 10, 1925. Since March, 1924, he had been deaf in his right ear. In December, 1924, he developed an unsteady gait. In November, 1925, hammering sounds developed in right ear with blurred vision, no headache, nausea or vomiting. Upon admission, examination revealed the following conditions: old healed Pott's disease, upper dorsal, bilateral papilloedema, marked nystagmus, coarse to left, fine to right, hypæsthesia of right cranial fifth nerve (including cornea), paresis of seventh nerve, sense of taste diminished on right side of tongue, right auditory nerve deafness, pedal ataxia on the right side, caloric test showed dead labyrinth on right side. Diagnosis was made of right cerebello-pontine angle tumor (acoustic nerve) for which an operation was done December 21, 1925. Ether anæsthesia. *First stage*, a curved, horse-shoe incision running from within one mastoid up over the occipital bone then down on the opposite side to the inner margin of mastoid. The occipital bone was entirely removed, including the posterior one-third of the foramen magnum, also the posterior portion of the Arch of the Atlas was removed. At this stage his general condition was such that operation had to be discontinued and the flap was temporarily sutured. *Second stage*, one week later—the dura was opened across both sides and then a fair-sized tumor of the right acoustic nerve was exposed.

The sheath was quite vascular and because of the generally poor condition of the patient it was not deemed wise to attempt complete enucleation of both the sheath and the tumor. Therefore, the sheath was split longitudinally and the tumor was completely enucleated from inside. When hæmostasis was complete the wound was closed, leaving the dura open for decompression.

His condition was very bad when he went off the table and that evening it was necessary to do a blood transfusion which very greatly improved his condition and after which he made a steady and satisfactory recovery.

In this case the tumor was approached by means of a curved incision passing across the head about 2 cm. above the superior curved line. At the outer ends this incision is turned downward so as to pass just within the posterior border of the mastoid on each side. The skin and galea are dissected downward until a place has been reached about 5 cm. below the superior curved line, when an incision is carried vertically through the attached muscles down to the occipital bone. In this way a good portion of muscle and fascia is left attached to the superior curved line for the purpose of the later closure. The muscles are then elevated from the occipital bone forward and downward until practically the entire occiput is exposed. From that point on the bone is removed, as usual including the posterior one-third of the foramen magnum, and the posterior arch of the Atlas in such cases as it is indicated. With this incision, in the majority of heads and necks, it is possible to retract this flap sufficiently to get a perfectly adequate exposure for work anywhere in the posterior fossa.

This incision avoids the necessity of the median leg of the so-called cross-bow incision and, therefore, saves a great deal of time both in the making and in the later suturing, also saves a certain amount of bleeding. The only objection which has been raised to this flap has been that by carrying the outer ends of the incision downward back of the mastoid, there has sometimes been a greater likelihood of the development of a spinal fluid fistula. However, with proper attention to the closure of the lower ends of the incision, the wound can be perfectly protected from such leakage.

The point of chief interest from the standpoint of surgical technic lies

SPINAL CORD NEUROFIBROMA

in the incision, *i e*, the horse-shoe flap without the cross-bow midline incision

This particular case with the kyphos of the uppermost dorsal vertebræ would seem an unusually bad case for this exposure. Nevertheless, with this single flap turned down there was a perfectly good exposure with which to reach this angle tumor

SPINAL CORD NEUROFIBROMA

DOCTOR TAYLOR presented a colored man, twenty-four years of age, who was admitted to Bellevue Hospital, January 17, 1927, with a history that six months previously he had developed (a) Numbness of the entire left side of the body (b) Two weeks later, weakness of the right leg (c) Chronic constipation (d) Two months after onset, vesical precipitancy (e) Three months after onset, weakness in left leg, and right leg had progressed to complete paralysis (f) Four months after onset, complete paraplegia plus weakness of right hand. Coughing, sneezing and yawning caused sharp pain in both arms. There was no history of venereal or other disease.

Physical examination showed the presence of (1) Spastic paraplegia with increased knee and ankle jerks (2) Absent plantar response (3) Symmetrical atrophy of both lower limbs, also of the hypothenar muscles of the right hand (4) Sensory level perfectly definite at cervical vi and vii, below which pin-prick was entirely lost, touch sensation much diminished, especially on the left side. Below the sensory level was a well-developed Brown-Sequard syndrome. Temperature sense was lost. Joint position lost in the toes. Vibration lost below the level of the pelvis. Deep pain lost in the calves. *X-ray pictures* were negative. *Blood and spinal fluid* negative. *Manometric test* showed complete block. *Pre-operative diagnosis* Tumor of spinal cord at level of cervical vi, right side.

Operation—January 20, 1927, a right hemilaminectomy of the v, vi and vii cervical vertebrae was done. When the laminae were removed six and seven were somewhat thinned and beneath them there became visible a tumor, dark in color, elastic in consistency and with very marked pulsation, such that it was suspected of being an aneurism for a time. Further exposure showed it to be ventro-lateral, extradural, extending from the sixth intervertebral canal, which was expanded to 1.5 cm in diameter, inward and upward along the ventro-lateral aspect of the dura. It was largest about 1 cm from the upper end where it evidently caused the most compression of the cord.

It was enucleated by sharp dissection and when completely removed showed both the anterior and posterior nerve roots of cervical vii incorporated in the tumor, most of the fibres lying between its capsule and the surface of the tumor proper. The dura was not opened.

His post-operative recovery was very rapid (a) Within twenty-four hours he began to move his legs (b) Four days after operation there was increased voluntary movement of toes, ankles, knees and hip-joints (c) Sensation to pin-prick and touch returned on the left side (d) Sensation to pin-prick and touch returned over the sacral area on the right side (e) Deep sensibility, joint position, deep pain, vibration—unchanged (f) Urinary precipitancy—gone. Progress has been very rapid since that time, he being able to walk with some assistance in balancing on the nineteenth day.

Pathological Diagnosis—Neurofibroma

Remarking upon this case the reporter said that inasmuch as a number of cases have been reported in which bilateral cervical laminectomy has been followed within a few months, or a year or two, by dislocation of the cervical spine, it would seem wise to adopt a method which would preserve as much

of the bones, ligaments and muscles as possible, in order to preserve the stability of the spinal column

In one case reported by Adson there was sufficient dislocation to have caused complete transverse myelitis, which later resulted in death

Two cases reported by Mixer showed perfectly definite dislocation, in one case without symptoms, and in the other case, which had passed from observation, a late fatal result which may or may not have been the result of forward dislocation

In a fourth case, in which a patient after complete bilateral cervical laminectomy returned after two years with well-marked disturbance of all four extremities, definite angulation with forward dislocation of cervical iii on iv is shown. It is probable that his neurological symptoms are not due to this dislocation at the present time. Nevertheless, the changes in the cervical column are certainly ominous for the future

Every laminectomy in the cervical region should therefore be primarily a hemilaminectomy for the purpose of exploration and then if occasion demands it, bilateral laminectomy may be done readily over as much or as little of the opposite side of the spine as may be necessary

CHRONIC INFLAMMATION OF CAUDA EQUINA

DOCTOR TAYLOR presented a third patient, a man, aged fifty-five years who was admitted to Bellevue Hospital, November 1, 1926, with a history of (a) Sharp pain in both lower extremities since October, 1925 (b) Pain rapidly extended into the lumbar region, followed by difficulty in walking, in May, 1926 (c) Sphincter disturbance developed in August, 1926

Physical examination showed (1) Atrophy and weakness of the glutei, ham-strings and calf muscles on both sides (2) Ankle-joints lost on both sides (3) Left knee-joint lost, right knee-joint diminished

Sensory examination showed loss of sensation in the sacral ii, iii, iv and v on the right side and sacral iv and v on the left side. *Manometric test* showed no block. *Lipiodol injection* showed a lesion at the level of the fifth lumbar vertebra. *X-ray plates* also showed considerable osteo-arthritis disturbance of the lower spine

November 10, 1926, he was subjected to a right hemilaminectomy from lumbar iii to sacral i, inclusive. The muscles were thick and the wound was at considerable depth, so that the procedure was somewhat difficult. When the dura was exposed it was found that there was a perfectly solid, hard tumor about 3 cm long and apparently 1.5 to 2 cm in diameter which lay just in the midline and which could not be satisfactorily exposed or dealt with through a hemilaminectomy. Therefore, the exposure was converted into a bilateral laminectomy. The dura was split over the hard tumor which, when exposed, proved to be most of the cauda equina matted into a hard mass by a chronic inflammatory process. After this mass had been separated into the various nerve bundles, a projection was felt extending backward from the anterior wall of the spinal canal, between lumbar v and sacral i. This projection was smooth and extended somewhat across the front of the spinal canal. It was thought to be a chondroma. The anterior layer of the dura was divided vertically as well as the posterior spinal ligament. Spinal fluid was constantly coming into the wound and when the dura and the vertebral ligament were divided, the flow was considerable.

On attempting to feel the tumor over which the incision had apparently been made, it could no longer be distinguished and a probe passed through the incision freely into the space between lumbar v and sacral i. Evidently the disc had liquified and this liquid, under tension, had projected backward,

simulating a chondroma and then had escaped through the incision, mingling with the cerebro-spinal fluid

There was a slight improvement in the neurological condition following the operation. There was very marked relief from his pains until he began to sit up.

In view of the complete laminectomy and the obvious damage to the intervertebral disc, it was felt necessary to have a well-made support before he was allowed to get up. Therefore, a plaster jacket was applied to lift the weight of his torso from the spine and put it on the iliac crests. In this case, had hemilaminectomy been feasible for the completion of the operation, it would have been possible to do a fusion of the remaining arches and spinous and articular processes, which would have given him earlier relief from the external supporting apparatus.

DR THOMAS A. SHALLOW (of Philadelphia) said that the question of the use of hemilaminectomy as a primary procedure in all tumors of the spinal cord should be questioned. It is true that in certain limited cases the exposure of the cord or the dura of the cord is all that is sufficient for a proper extirpation of the growth. In certain cases a complete laminectomy is not only advisable but imperative. This is stated with a full realization of the points brought out by Doctor Taylor of tumors of the cervical region where a complete laminectomy had been performed on several of the lamina. Doctor Taylor admits that under certain conditions a complete laminectomy is absolutely necessary for the completion of the operation. He claims that it requires not more than ten minutes to convert a hemilaminectomy into a complete laminectomy. There is valuable time lost after the dura has been opened and the cord exposed, it is at this period in the operation when shock plays a strong rôle in the question of mortality. The speaker believed that in all tumors involving the membrane in front of the cord and tumors within the cord a complete laminectomy is obligatory.

In the tumor of the substance of the cord in the cervical region which Doctor Shallow operated upon, he believed it could not have been removed through a hemilaminectomy, and was sure that had he had only a hemilaminectomy to begin with and then converted this into a complete one, he would have lost his patient through shock on the table from the added ten minutes of exposure of the cord.

DR CHARLES A. ELSBERG said that since Doctor Taylor had reintroduced the curved incision instead of the cross-bow incision which everyone took up on Cushing's advice, surgeons have been using the single incision more and more often. For many years Doctor Elsberg was opposed to the operation of hemilaminectomy, mainly because the operation is not quite as simple and one could not obtain as free and wide exposure of the spinal canal, and because—in operating around the spinal cord—it is of great importance to handle the cord as little as possible. Consequently he felt that a complete laminectomy was indicated in all instances except where the nerve roots on one side only were to be divided. He thinks, however, that the arguments Doctor Taylor has presented for hemilaminectomy, especially in the cervical

region, are very good ones and that he is right when he says one should begin with hemilaminectomy and then, if necessary, increase the bone removal until both laminae and spinous processes have been removed. In Doctor Taylor's case of extra-dural tumor it would seem there may already have been some bone changes. But that does not interfere with his argument, which is an excellent one, and in the future, Doctor Elsberg said he will do hemilaminectomy in the cervical region more often.

DR A P C ASHHURST (of Philadelphia) asked Doctor Taylor if he had had trouble from sloughing of the scalp as a result of cutting the occipital artery on both sides. The speaker previously had used the cross-bow incision of Cushing, but he had one patient who had extensive sloughing of the scalp and after that he heard of similar experiences in the hands of other surgeons, because the occipital artery was divided low down. Then his associate, Dr Temple Fay, called his attention to the midline incision from theinion to the upper cervical region, as described last year by Doctor Frazier, securing more room if necessary by dividing the spinal muscles from within outward below the distribution of the occipital artery. This gives good exposure and there is no subsequent sloughing.

DOCTOR TAYLOR, in closing the discussion, said that he had been doing hemilaminectomy since 1903 and had removed good-sized tumors from within the dura, dividing the posterior roots up both sides, in other words, he got good exposure. Doctor Elsberg and he had discussed this from different points of view for fifteen years and it was pleasant to learn that they were now in accord. It takes a certain amount of facility to acquire the amount of exposure this procedure may give. All those things, regarded as difficult for hemilaminectomy, have been done and the patients have gotten well and stayed well if the proper tools were employed. Of course one cannot get as free and wide an exposure as if one takes both sides to the same degree, but one can get sufficient, so why waste the bone on the other side? Then, too, if hemilaminectomy is done and a lesion is found that cannot be satisfactorily handled through hemilaminectomy, it can be translated to double laminectomy in two minutes. In the old days when neurological localization was not as good as it is now, it was always a possibility that the tumor would be found to be far above or below the apparent localization, and if full laminectomy had been done very little spine was left when the tumor was finally removed. But exploration could be done through hemilaminectomy and then, if more room were needed, it could be taken without so much damage. As to Doctor Ashhurst's question, Doctor Taylor said he had never seen sloughing in this incision and thought there must have been something unusual in Doctor Ashhurst's case. So many had been done without any sloughing that when it occurred the cause must lie elsewhere, than in the division of the occipital artery. With regard to the midline incision, the speaker was attracted by that for cerebellar tumor as it gives good exposure. He had been enabled by it to handle a left lobe cystic glioma successfully.

DILATATION AND PERFORATION OF THE CÆCUM

DILATATION AND PERFORATION OF THE CÆCUM IN OBSTRUCTION OF THE DESCENDING COLON OR SIGMOID

DR JOHN DOUGLAS said that if, as the result of complete obstruction, the intestine above the point of closure becomes sufficiently distended, perforation may ensue. Usually, the maximum distention and perforation occurs immediately proximal to the point of obstruction. Perforation probably occurs only as a result of mechanical ileus. In the small intestine it is usually located on the intestinal surface most distant from the mesentery.

It has been shown experimentally and clinically that the mechanism of this process depends on interference with the blood supply, due to pressure from within the intestinal lumen acting on the thin wall and narrow lumen of the vessels. This pressure obliterates first the veins, which rupture and cause blood extravasation. Then the additional pressure occludes the arteries and necrosis of the intestinal wall results.

In the large intestine, location of the maximum distention may not be immediately above the point of obstruction, but may be at some distance proximal to this point. That is, in obstruction of the descending colon or sigmoid, great distention of the cæcum may occur, which may result in splitting of the serous coat of the cæcum, or even terminate in perforation and general peritonitis. This condition has a bearing on diagnosis, complicates the symptom complex, and may have a determining influence on the operative procedure. His attention was first directed to this condition by the following case.

A woman, age sixty-five, was admitted to St. Luke's Hospital, June 26, 1924, with symptoms of acute intestinal obstruction. Constipation and gas pains had been present for four months. For ten days before admission she had cramp-like pains in the abdomen with dull pain on the left side under the ribs. Bowels had not moved for forty-eight hours, and vomiting had been persistent for twelve hours. Radiograph, after opaque enema, showed obstruction at the junction of the descending colon with the sigmoid, and marked gaseous distention and dilatation of the cæcum. At operation, an annular carcinoma of the descending colon was found, but the cæcum was so distended that the peritoneal coat had split along a distance of 4 to 5 cm. Although the small intestine and colon between the cæcum and point of obstruction were also distended, the dilatation was far less than that of the cæcum. The condition of the cæcum made it advisable to perform a cæcostomy rather than to attempt immediate delivery of the growth which was above the sigmoid, making mobilization difficult. The resection of the growth was done at a later stage and the cæcostomy closed at a third operation. There have been no signs of recurrence to date.

While this dilatation of the cæcum has been frequently observed, even proceeding to the degree of splitting of the serous coat during operation, it is not well known by the majority of surgeons. Still less so is the fact that as a result of low obstruction in the large intestine the cæcum may become distended to the degree of perforation. This is illustrated in the two following cases.

A man, age fifty-four, was admitted to the Knickerbocker Hospital, November 19, 1924, with a history of general abdominal pain for ten days, finally localizing in the right lower quadrant. Very small movements from

bowels at first, later none. Had vomited frequently, but had continued working and had no medical attention until day before admission to the hospital, when all symptoms became worse. He was admitted in a moribund condition with all the signs of advanced general peritonitis, and died within a few hours, no operation being done. At autopsy, a carcinoma at the rectosigmoid junction was found, and a general peritonitis, due to fecal extravasation from a perforation of the cæcum at the base of the appendix.

A man, age sixty-five, was admitted to Bellevue Hospital, April 19, 1925, with history of constipation for six days, vomiting five days, distention and pain increasing up to admission. The history indicated intestinal obstruction—the physical signs of general tenderness and rigidity, with elevated temperature and blood count, a general peritonitis. At operation, a carcinoma of the pelvic colon was found with a general peritonitis, due to perforation of the cæcum. A cæcostomy was done, but the patient died thirty-six hours later.

These cases are not presented to illustrate a new observation, but to recall to mind an old one apparently not known, or forgotten, by many. Twenty-five years ago, in 1902, Willy Anschutz, in the *Archives für Klinische Chirurgie*, Bd lxviii, p. 195, published a report of five cases of obstruction: two of carcinoma of the splenic flexure, two of the sigmoid, and one case of volvulus of the sigmoid. All showed great distention of the cæcum, and one had perforated with resulting peritonitis. He explains this phenomena in certain cases by the resistance of the ileocæcal valve and the fact that the normal diameter of the cæcum is greater than that of the rest of the colon. That this distention should be greater, therefore, in the cæcum by natural physical law he proves by attaching two rubber finger cots or balloons of different diameters at the ends of a T-tube and injecting air at the centre. Although the walls of the balloons were of equal thickness, the one of larger diameter always became the more greatly distended.

It has seemed worth while to recall attention to this condition, as, should the physical signs or the X-ray evidence as shown by a plain plate, of a greatly distended cæcum, in the presence of symptoms of intestinal obstruction be present, it may point to the possibility of the obstruction being low in the colon. Also this cæcal distention, resulting in pain and tenderness on the right side may cause a mistaken diagnosis of appendicitis to be made, as was the case in a patient with a carcinoma in the lower part of the sigmoid recently seen. It is also suggested that this tendency of the cæcum to dilate more than other portions of the colon, when the ileocæcal valve is especially resistant, may have some bearing on the vague, irregular, right-sided pains in constipated patients, thus causing a faulty diagnosis of chronic appendicitis to be made.

MEGACOLON

DR RICHARD W. BOLLING presented two patients as illustrating one of the problems in the treatment of megacolon, or speaking more correctly, of megasigmoid and megarectum. As the anatomical condition was similar, the two cases were presented together.

They were both admitted to the medical side of St. Luke's Hospital in the summer of 1922, at which time one was thirteen and the other fifteen years of age. In both the immediate history was of abdominal pain, diarrhoea and loss of weight. In the case of the younger boy there was a history of stomach trouble and constipation since birth and he had been under obser-

CARCINOMA OF THE COLON

vation at the hospital for one year with recurring attacks similar to the present one. The older boy had a definite history for only one month. In each patient there was an enormous fecal impaction, with greatly dilated rectum and sigmoid colon.

After the relief of the immediate symptoms, the patients were transferred to Surgical Division "A" and assigned to Doctor Bolling for treatment. After careful consideration, resection of the sigmoid colon was carried out and a little over two feet removed in each instance. This portion of the intestine was greatly dilated and the wall thickened. The process obviously involved the rectum. The remainder of the large intestine was relatively normal, though in one case considerably dilated. In this case an axial anastomosis was effected. In the other a lateral anastomosis was carried out on account of the great disparity in the size of the dilated rectum and the apparently normal descending colon. Convalescence was uneventful and within a year one patient gained 22 and the other 29 pounds.

The younger patient was shown to this society May 9, 1923. There persisted in both patients a marked tendency to constipation and in the second and third year after operation, each patient had an attack similar in all respects to the ones before operation. Since that time there have been no attacks of such severity and although evacuation of the bowels is irregular, the condition is kept under fair control by the patients themselves. The involvement of the rectum was fully recognized at the time of operation, but the operation was performed in the hope that removal of the sigmoid loop would increase the efficacy of ordinary medical measures.

Cases such as these should not, in Doctor Bolling's opinion, be included in the group of so-called idiopathic dilatation of the colon, but should be regarded as instances of acquired megacolon resulting from a tendency to fecal stasis due possibly to some developmental defect in the wall of the intestine.

A similar condition is apparently prevalent in Argentina and in 1922 (Corbin, F. G., *Megasigmoid, Megarectum, Fecal Bolus. Surg., Gynec. and Obst.*, vol. xxxv, pp. 23-34, July, 1922) Doctor Corbin referred to a personal experience of over two hundred cases of fecal impaction with enormously dilated rectum and sigmoid. In his article he makes the statement that more deaths occurred in Mendoza from this condition than from appendicitis, gastric ulcer, duodenal ulcer and cancer of the rectum combined.

In a recent article (Mizzzi, P. L., *Total Colectomy as a Treatment of the Megasigmoid. End-to-End Anastomosis. Archives of Surgery*, vol. xiii, pp. 837-845, December, 1926) Doctor Mizzzi, of Cordova, reports recurrence following similar operations and advises total colectomy with implantation of the ileum into the recto-sigmoid.

This procedure would seem scarcely justified in cases such as the ones shown by Doctor Bolling. In the future in similar cases Doctor Bolling will be inclined to defer operation and depend upon medical measures, operating only for volvulus or other acute condition. This of course does not apply to true Hirschsprung's disease, in which the rectum is rarely involved.

CARCINOMA OF THE COLON

DR RICHARD W. BOLLING presented a man, aged fifty-four, as a recent result of the application of the multiple stage operation in carcinoma of the cæcum. The patient was admitted to St. Luke's Hospital in July, 1926, with a history of epigastric distress for three and one-half years and of a tumor

in the right side of the abdomen for three years. There had been no symptoms of intestinal obstruction, but anæmia, weakness and loss of weight had been progressive. On admission the patient appeared in very poor general condition and his hæmoglobin was 45 per cent.

After transfusion, Doctor Bolling operated and found a bulky growth in the cæcum. The cæcum and ascending colon were fixed in the usual manner. The growth in the cæcum, with the adjacent ascending colon and ileum, was exteriorized and cut away with the cautery, after the walls of the ileum and ascending colon had been united. A tube was introduced into the ileum.

The first operation was carried out July 20. A clamp was applied to the spur a few days later and the fistula was closed August 19. The patient was discharged September 11. A small sinus persisted for several weeks but the wound is now soundly healed.

This type of operation is not usually indicated in growths of the cæcum, but there are exceptions in which its application is very useful.

Doctor Bolling presented also a woman who was admitted to St. Luke's Hospital in March, 1922, with a history of diarrhoea, abdominal distention and loss of weight. At that time she was twenty-six years of age.

Röntgen-ray examination indicated partial obstruction in the lower sigmoid and the sigmoidoscope revealed an irregular growth eight and one-half inches from the anus.

Doctor Bolling operated and a growth occupying the lower sigmoid and growing into the lumen of the gut was found. Resection of the growth with immediate axial anastomosis after the tube method was done. The pathological report was adenocarcinoma of the sigmoid without involvement of the regional lymph-nodes.

Convalescence was uneventful and the patient was discharged twenty-one days after operation. Following her discharge she received a series of Röntgen-ray treatments and a temporary artificial menopause was induced. She was married about three years ago and recently consulted Doctor Bolling in regard to a perineal laceration sustained at the birth of a child two years ago.

She has no symptoms referable to the original condition and it is now a few weeks less than five years since her operation.

TUMORS OF THE CÆCUM

DR JOHN F ERDMANN (of New York) read a paper with the above title, for which see page 722.

DR GEORGE P MULLER (of Philadelphia) said that he had had nine or ten cases of carcinoma of the cæcum, three of tuberculosis and one case of undetermined origin. This patient was a young Japanese who for three years had had slight pain in the right iliac fossa. Recently there had been an acute exacerbation. The pre-operative diagnosis was acute appendicitis. At operation the mass was found to be in the wall of the cæcum and about four cm in diameter. It was thought to be cancer or tuberculosis and the cæcum and ascending colon were removed. The mass in the cæcum was a localized abscess in the wall which on culture was found to be sterile. The cases of tuberculosis were of the hyperplastic variety in two instances and one was ulcerated. This man had no other evidence of tuberculosis, yet he

had a thickened ascending colon containing five ulcers. All of the cases of tuberculosis recovered. In regard to carcinoma of the cæcum, the speaker had noted that Doctor Erdmann had eighteen cases as compared to approximately twenty-two on the left side. Usually the proportion is found to be greater. The speaker believed that in these right-sided tumors obstruction is uncommon, very few of his had acute obstruction. When the end of the ileum was involved the obstruction was chronic and the small bowel hypertrophied. Pain was of more consequence than on the left side. His experience with the X-ray is that of Pancoast who thinks the picture of cancer undistinguishable from that of tuberculosis of the cæcum. Doctor Erdmann had referred to the finding of Craig and McCarty, that in 32 per cent the lymph-nodes were involved. It is better to put it the other way and state that in sixty-eight there is no metastasis to the lymphatics, hence there is a good chance of curing carcinoma of the cæcum. The operation is very easy. The speaker said he usually makes his incision closer to the bowel than pictured by Doctor Erdmann. In resection for cancer of the cæcum he has had no trouble with the duodenum. Only in carcinoma of the hepatic flexure is one liable to run foul of the duodenum. Regarding the method of operation, Doctor Muller said he had done end-to-end anastomosis and end-to-side, and had found no difference. In the end-to-end one has to trim the bowel, and the speaker was more partial to the end-to-side method. Lateral anastomosis has given him an obstruction in two cases. If there is considerable obstruction a preliminary operation must be thought of, but there is danger of infection from a preliminary ileostomy. So unless there is a real shut down it is better to do the entire procedure at one time. Doctor Muller agreed with Doctor Erdmann that infection is common. These patients are septic and one has to work carefully. Most of the speaker's cases had bled and some he had had to transfuse. One patient had an ileostomy and then bled and was transfused two or three times. At the operation to remove the growth it was found that it had advanced so far during this period of three months as to be inoperable.

DR JOSEPH A. BLAKE said in regard to the malignancy of right-sided growths, he had found them to be more so than on the left side of the abdomen. Recurrences had usually taken place within five years, and some in a very short time. The last recurrence, or rather extension, which he had observed only that day, was in a woman twenty-eight years of age, from whom the cæcum ascending colon and terminal portion of the ileum had been excised for carcinoma of ileocolic junction eight weeks ago, at which time the ovaries were normal, but to-day both were found to be the site of carcinomatous growths six inches in diameter. Some of these tumors are very malignant, much more so than those occurring in the sigmoid. There is a low malignancy in carcinoma arising in the appendix which lowers the general mortality of right-sided carcinomata. Doctor Blake said he had generally done the end-to-side anastomosis.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held February 23, 1927

The President, DR WILSON MARRIN, in the Chair

CÆCAL ULCER—LYMPH-NODE HYPERPLASIA

DR OTTO C PICKHARDT presented a girl, five years of age, who was admitted to the Lenox Hill Hospital, February 20, 1923, on account of pain in the abdomen, which had lasted for four days. Examination showed the abdominal wall normal to pressure on left side, right side spastic. Just external to the border of the right rectus, there could be felt a tender mass about two inches long and three-quarters inch broad, not movable and unyielding. Child was kept under observation for ten days, during which time the bowels moved regularly. May 5, 1923, abdominal incision revealed an irregular growth of lymph-nodes between the folds of the mesentery of the ascending colon, extending up to and partially surrounding the gut to the hepatic flexure and downward to the ileo-cæcal junction. The mesenteric lymph-nodes of the distal six inches of the ileum were also involved. The lumen of the involved portion of the gut though patent was still so much reduced that the operative procedure at this time was limited to an end-to-side anastomosis of the ileum with the mid-portion of the transverse colon and the removal of two of the nodes for examination which showed simple hyperplasia and œdema, no evidence of tuberculosis or malignancy. A good operative recovery followed. Two weeks later there was done a resection of the terminal four inches of the ileum, cæcum, ascending colon complete and three inches of transverse colon, together with the mass of retroperitoneal lymph-nodes. At this time it was found that the mass had decreased materially in size and that perfect healing of the anastomosis previously done, had taken place. The first week after operation was somewhat stormy, but by the eighth day, temperature was normal, bowels moved regularly, incision had healed by primary union. Examination of the mass removed showed suppurative colitis with perforation, chronic pericolicitis and lymph-node hyperplasia. Two centimetres above the ileo-cæcal valve was a small perforation extending directly into a mass of lymph-nodes. The track of the perforation was lined with granulation tissue and covered in places with cylindrical epithelium derived from the mucosa of the gut. In places minute abscesses are present and giant cells of a foreign body type occasionally seen. Cause of lesion was not determined. Since her recovery she has remained well and developed as a normal child, except for an effusion into the left knee-joint, March, 1924. Abdomen is somewhat big, scars are firm, bowels move regularly twice a day. Now, practically four years after the resection at the age of nine, she is well, four feet three inches in height and weighs fifty-three pounds.

OSTEOGENETIC SARCOMA OF HUMERUS

DR OTTO C PICKHARDT presented a woman, age twenty years, who was admitted to Lenox Hill Hospital, July 17, 1924, on account of pain and inability to use her left arm. Pain in upper left arm was first noticed six

RE-FORMATION OF ULNA FOLLOWING EXTENSIVE OSTEOMYELITIS

months ago. No history of trauma, swelling, redness, or other external physical signs. Examination showed an evident pathological fracture just below the greater tuberosity of the left humerus. No axillary lymph-nodes felt. Blood count shows distinct secondary anaemia. Wassermann examination is negative and X-rays show about two inches below the greater tuberosity there is an area of bone destruction. The appearance is rather suggestive of a medullary growth, possibly sarcoma. There is no appearance of metastatic growth in the lungs. In July, 1922, a biopsy was performed and curettings from the medulla of the humerus obtained. There appeared to be a sort of capsule around the fracture and the muscle seemed normal and not infiltrated.

Pathological examination showed tumor cells varying considerably in size and for the most part fairly large. The cell outlines are poorly defined though the cells appear polyhedral or round in shape. The cells show chromatic nuclei and a slightly acidophilic granular cytoplasm. Mitotic figures are numerous. There are a number of true tumor giant cells and giant cells of the foreign body type, the latter cells being most numerous in the fibrosarcomatous areas. *Diagnosis* Actively growing sarcoma of the humerus.

July 28, 1924, a disarticulation of the left arm at the shoulder-joint was performed and the axilla cleaned out. As much muscle as possible was cut away with the aim from the shoulder, leaving the acromion and the coracoid processes bare. There was no evident direct extension visible in muscle, and the muscle and lymph-nodes were soft and hyperplastic. Pathological examination of the lymph-nodes showed no evidence of metastasis. Post-operative recovery was normal except for some referred pain in the ulna and some sloughing of the skin flap and fat necrosis with infection in the axilla.

The patient had received before operations two deep X-ray treatments and post-operatively received three more. She left the hospital September 13. February 8, 1926, she was re-admitted with an acute spontaneous right pneumothorax. No cause for this could be ascertained, and X-rays showed no evidence of metastasis or tuberculosis. This condition cleared up in seventeen days and she left the hospital. During the whole of the intervening time between the disarticulation and the present, which is now two and one-half years, except for the pneumothorax, she has had only minor ailments. She has complained of pain in the corresponding region of the right humerus, which has been attributed to a hypertrophy of the deltoid muscle and she has occasional headaches attributed to her persistent secondary anaemia and eye-strain. All X-rays of the right arm, lungs, and skull, are persistently negative for metastases. This patient is shown (1) because of her apparent freedom from metastases after two and one-half years, and (2) because a comparatively conservative operation has enabled her to support herself as an embroiderer during this period.

RE-FORMATION OF ULNA FOLLOWING EXTENSIVE OSTEOMYELITIS

DOCTOR PICKHARDT showed also a boy, five years of age, who was admitted to the Lenox Hill Hospital, November 24, 1919, on account of pain and swelling of the left forearm which had been progressively increasing for one week. When admitted the left forearm was swollen, tender, red, and fluctuating along the outer border over the ulna. This area extended from the wrist to within a short distance of the elbow. Other extremities normal. The same day the limb was subjected to incision and drainage, six ounces of thick, yellow pus were obtained, which on culture showed staphylococcus aureus. Following this, five more operations were performed. At the fourth



FIG 1 —Massive osteomyelitis of ulna Skia-graph taken March 1 1920

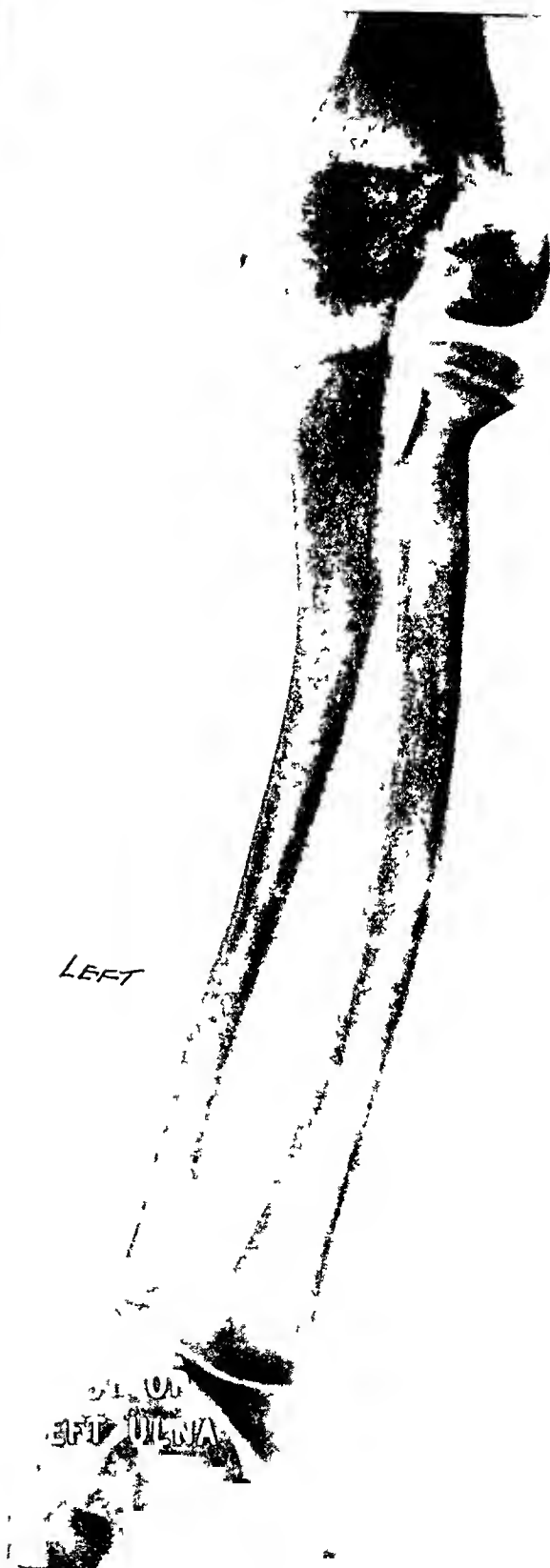


FIG 2 —Same forearm shown in Fig 1 after lapse of seven years

RE-FORMATION OF RADIUS FOLLOWING EXTENSIVE OSTEOMYELITIS

operation, December 18, a small sequestrum from the ulna was obtained. An X-ray at this time revealed an osteomyelitis of the entire shaft of the left ulna, extensive sequestration has occurred. March 10, 1920, an incision was made from the wrist to the elbow-joint over the ulna. A sequestrum was found free at the lower end and loose within the involucrum, and removed. A few smaller sequestria were also removed. X-ray at this time reveals an old osteomyelitis of the whole ulna (Fig 1). There is a formation of involucrum almost the entire length of the bone. The entire shaft has now become a sequestrum. Following this last operation, the wound healed without further difficulty, and the patient was discharged April 7, 1920.

The patient was lost track of until he returned to the Lenox Hill Hospital, January 15, 1927, because of a dense mass in the right axilla. This proved to be a chronic tuberculous lymph-adenitis and the mass was removed on January 20, 1927. At present there remains a small sinus.

An X-ray of the left forearm seven years after the practically complete removal of the ulna shows almost complete regeneration of the bone (Fig 2). It has grown evenly with the radius and only in its upper end does it show any roughening that would point out the location of the old trouble. The coronoid process is one cm longer than on the right side.

Present examination of the left forearm shows the old scar somewhat adherent to the ulna. Viewed anteriorly there is no deformity. There is present the same power as in the right normal forearm. There is perfect pronation and supination. Flexion is normal and the only abnormality is a loss of about five degrees in extension because of bony impingement. The case is shown because of the unusually perfect re-formation of a bone after an extensive osteomyelitis.

RE-FORMATION OF RADIUS FOLLOWING EXTENSIVE OSTEOMYELITIS

DR DEWITT STETTEN presented a young man, seventeen years of age, who in November, 1919, when nine years old, following a slight trauma, began to complain of pain, swelling and redness of the left wrist. He had high temperatures and there was a point of exquisite tenderness on the radial side of the left wrist. X-ray examination showed a small defect in the bone on the radial side of the lower end of the diaphysis of the radius, and some elevation of the periosteum in this region. December 4, a large subperiosteal abscess was opened and drained, and the lesion in the lower end of the diaphysis of the radius was thoroughly curetted. Culture of the pus showed a staphylococcus aureus infection. This procedure, notwithstanding the osteomyelitis, extended through the entire radius. January 3, 1920, the entire radius was opened and converted into a long boat-shaped cavity. The entire shaft of the radius thereupon sequestered with a certain amount of involucrum forming, particularly at the upper third. February 19, 1920, the sequestrum was loose, and after dividing it in its middle with a circular saw, the two halves were extracted (Fig 1 A). Some disintegration was noted at each end, especially at the lower. February 28 an abscess was incised on the inner side of the arm, and May 18 another incision on the radial side of the forearm was made below the elbow, some pus was evacuated from a probable elbow-joint abscess, and two loose fragments of the radial head were removed (Fig 1, B). The sinuses at the wrist and at the upper angle of the main wound were curetted. Within the next two months all the wounds healed and remained closed. No regeneration, however, occurred in the middle third of the radius, so that a defect of about three and a half inches persisted. This resulted in a false joint in the middle of the forearm and marked radial adduction of the hand in spite of all efforts to prevent this

deformity, so that function of the forearm was markedly interfered with November 21, 1921, nearly two years after the initial infection, and about a year and five months after all wounds had entirely healed, the defect still remained unchanged and an inlay bone graft operation was performed. The skin was excised, the exposed pointed ends of the regenerated upper and lower segments of the radius were exposed and removed, and a V-shaped mortise was made at each end. A section of the left tibial crest with periosteum was taken for the graft and the ends of the graft shaped to fit the mortise, so as to fit snugly into the defect with the hand in as full ulnar adduction as possible,

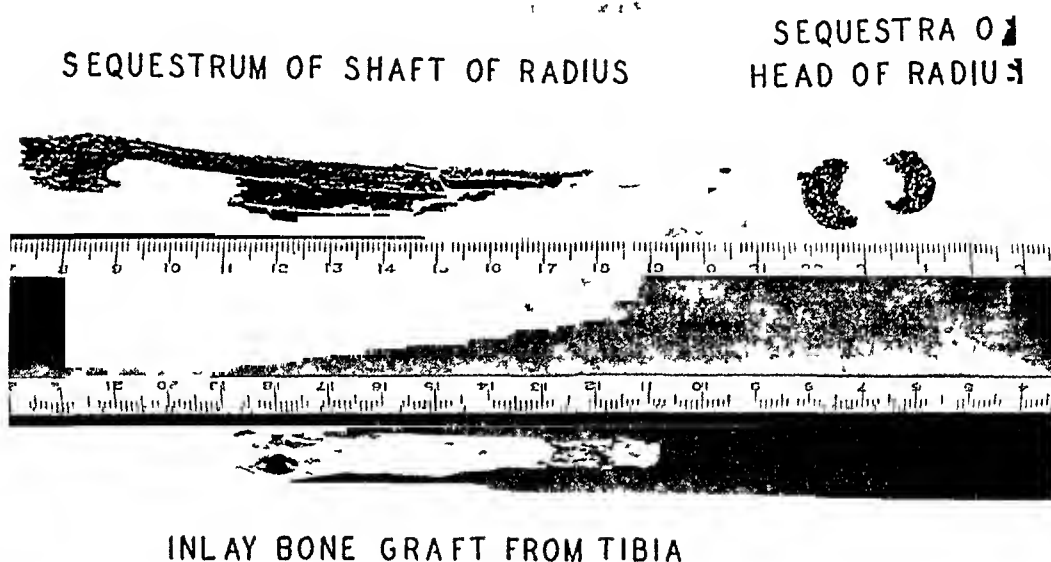


FIG. 1.—A Sequestrum of shaft of radius after previous osteotomy. Sequestrum has been divided in middle for purpose of extraction and is held together by wires. B Sequestra of head of radius. C Inlay bone graft removed because of suppuration.

considering the contraction of the radial muscles. Holes were drilled into the upper and lower segments of the radius and at each end of the graft, and the graft was secured in place at each end by kangaroo ligatures. Unfortunately, the wound did not heal by primary union, probably because of the persistence of pyogenic bacteria in the tissues, and December 3, 1921, it was necessary to open the wound and evacuate some pus. X-ray examination December 19, 1921, showed some callus forming around the upper end of the graft and some bone absorption in the lower fragment of the radius around the lower end of the graft (Fig. 2). December 20, 1921, another small abscess was opened. The wound continued to drain but no attempt was made to disturb the graft. February 21, 1922, X-ray examination showed the graft still in place but somewhat disintegrated, considerable more bone absorption in the lower end of the radius around the lower fragment of the graft, and a thin bridge of bone connecting the two radial fragments. April 6, 1922, the graft was removed. It was considerably disintegrated, particularly at the upper end (Fig. 1, C). After the removal of the graft there was apparently no false motion in the radius which appeared now to be a solid bone. X-ray examination showed that the bridge of the bone connecting the upper and lower radial segments had increased considerably in size, and that the area

RE-FORMATION OF RADIUS FOLLOWING EXTENSIVE OSTEOMYELITIS

of bone absorption in the lower fragment was filling in. After the removal of the graft the wound healed promptly and has not reopened since. The connecting bridge of bone between the upper and lower fragments of the radius rapidly increased in density (Fig 3), and the patient soon began using the arm for every purpose and apparently without any marked disturbance. The reporter had not seen the patient for five years. He has had no



FIG 2—Radiograph about one month after inlay bone graft operation to bridge persistent defect in middle third of radius. Note beginning callus formation around upper end of graft and bone absorption in lower end of radius and around lower fragment of graft.

trouble with his forearm since. Although there is still a rather noticeable deformity with a marked concavity of the radius and some radial adduction of the hand, function of the wrist, and especially the elbow, are almost normal in spite of the previous apparent elbow-joint suppuration. Supination, however, is rather definitely restricted. X-ray examination shows an astonishing restoration of the radius. The regeneration has been quite complete, including the radial head. The bone is comparatively little deformed with only slightly increased density in the middle third in the region corresponding to the persistent defect, only a moderate thickening of the lower third, and only slight ulnar and posterior bowing. The growth of the radius has been relatively normal, keeping good pace with that of the ulna (Fig 4).

This case is presented first, to show the extent to which regeneration can replace a long bone after practically complete sequestration, and second, to



FIG 3—Radiograph six months after inlay bone graft operation and seven weeks after removal of graft. Note bridge of solid bone between the two radial segments.

illustrate the value of an inlay bone graft to complete an imperfect restoration. It is interesting to note that the effect of the graft was quite satisfactory in spite of suppuration, and the eventual necessity for removal of the graft. Apparently the presence of the graft stimulated the bone formation from either end of the radial segments, or sufficient osteogenesis proceeded from the periosteum of the graft to completely bridge the defect.

NEW YORK SURGICAL SOCIETY

DR J P HOGUE believed this condition was not as rare as has been believed. He had personally seen three such cases, one of which he reported before this Society three years ago in which the whole shaft of the humerus was removed in February following an osteomyelitis caused by a compound fracture received the previous June. At the time of operation a new humerus had already formed around the sequestrum. This patient was a boy twelve years of age who had had a severe case of osteomyelitis and the sequestrum extended from the proximal to the distal epiphysis.

DR JOSEPH WIENER questioned if the bone inlay had anything to do with the result in these cases. Years ago he operated on a boy who, following a



FIG. 4.—Radiograph seven years after almost complete sequestration of radius and two years and two months after inlay bone graft operation. Note complete reformation of radius including radial head with relatively little deformity.

streptococcal throat, had had osteomyelitis of the radius. In cutting down on the radius he split the periosteum which was already loosened from the bone. He lifted out the entire radius from the wrist to the elbow in one mass. There was subsequently perfect re-formation of the bone. Doctor Wiener believed that the periosteum did all the work of re-formation of bone in these cases.

DOCTOR PICKHARDT, in closing the discussion, said that the length of time it took this ulna to sequestrate was three months and three weeks, nearly four months. Before the last operation the X-ray showed an apparently perfect sequestrum, but at operation it was found the sequestrum was not loose and so no attempt was made to remove it. The criterion by which one should judge the arrival of the time for the removal of the sequestrum is its complete separation—in other words, when it is completely cast away as a slough and is lying loose. Probably the type and severity of the infection have something to do with the length of time, as well as the age of the patient. This case was not shown for its rarity but for the good result which nature obtained.

DOCTOR SEITZ, in closing the discussion, said that he waited nearly three months before removing the sequestrum of the shaft of the radius, which had become quite loose by that time. X-ray examination then showed some involucrum, particularly of the upper third and around the lower extremity, but nothing in the middle third of the bone. The case was kept under a period of observation for nearly two years after the initial infection,

MESENTERIC THROMBOSIS

one year and nine months after the removal of the sequestum of the shaft, and one year and five months after all wounds had entirely healed. As there was absolutely no indication of any regeneration whatsoever in this defect in the middle third of the bone during this period, and as a false joint persisted, it was only then decided to perform the inlay bone graft operation. In spite of the fact that the wound did not heal by primary union and it was necessary eventually to remove the bone graft, regeneration began promptly after the bone had been implanted. Periosteum was implanted with the inlay bone graft, and it is possible that this periosteum was the main factor in the osteogenesis. In view of these facts it appears rather certain that had the inlay bone graft operation not been done in this case, at any rate, the regeneration would not have occurred. The failure of the bone to regenerate without the aid of the inlay bone graft was probably due to the large subperiosteal abscess with the extensive destruction of the periosteum.

MESENTERIC THROMBOSIS

DR GUILFORD S. DUDLEY presented a man who on September 23, 1925, J. B., when thirty-eight years old, was operated upon at Bellevue Hospital (Second Division) for acute suppurative appendicitis. His appendix was removed and the peritoneal cavity drained. His wound healed completely by February 21, 1926, and remained healed until November 30, 1926. He was well until October, 1926. At that time he began to suffer marked discomfort in his right lower abdomen and said that he felt as though there were something within the abdomen. Although this symptom persisted off and on until the onset of his acute illness, he disregarded it as far as possible and continued at his work.

November 30, 1926, violent generalized abdominal cramp-like pain accompanied by repeated vomiting, chills and fever, caused him to reenter the hospital. At this same time the healed drainage track broke open and discharged sanguino-purulent material. Examination showed a fever of 101° , leucocyte count of 27,000 with 91 per cent polymorphonuclears and tenderness in the right lower abdomen. His abdomen was not rigid or distended and he had had a daily bowel movement until the day preceding admission. No abnormality was detected in his cardiac, respiratory, urinary or nervous systems. He was observed for twenty-four hours, during which time enemata were ineffectual, vomiting persisted, and became fecaloid in type, but his abdomen did not distend.

Operation revealed a six-inch loop of gangrenous small bowel partially rotated upon its mesentery and adherent to the right lateral parietes. The rotation was not sufficient to occlude the bowel lumen and no occluding band of adhesion was present. Between this loop and a nearby adherent loop was a localized intraperitoneal abscess. No foreign body was found. The bowel proximal to the gangrenous loop was but moderately distended and the bowel distal to it was not collapsed. The involved area was removed, Murphy button end-to-end anastomosis accomplished, rubber dam used for drainage, and the abdomen closed. Convalescence uninterrupted, Murphy button passed by rectum spontaneously on the twelfth post-operative day.

Microscopical examination showed relatively normal mucosa of the small intestine, terminating abruptly in necrotic tissue, oedema, hemorrhage and polymorphonuclear infiltration in the submucosa while in the muscularis

and serosa the process appeared somewhat older, as shown by granulation and fibrin. Several fairly large vessels were thrombosed.

Is it reasonable to assume that, during the two months preceding his operation, repeated attacks of partial volvulus occurred and that the resultant trauma to the mesentery resulted ultimately in the thrombosis of its vessels?

RETROPERITONEAL TUBERCULOSIS

DR GUILFORD S DUDLEY presented a girl, twenty-six years of age. In 1919, her appendix and a right ovarian cyst were removed. During the year preceding her present illness she suffered from ill-defined gastric symptoms and lost about thirty pounds weight.

December 14, 1926, while at business, she became acutely ill with severe epigastric pain associated with nausea and vomiting and was operated upon at another hospital one and one-half hours later. Lower abdominal adhesions were freed and a right cystic ovary removed. She left the hospital December 24, 1926, and three weeks later was admitted to the Second Surgical Division of Bellevue Hospital with a recurrence of acute symptoms, a fever of 101° , leucocyte count of 14,000 with 82 per cent polymorphonuclears, no eosinophilia, 4,300,000 erythrocytes and 80 per cent hæmoglobin. Wassermann reaction negative. A firmly resistant mass, tender to palpation, was present in the upper abdomen. It could not be distinctly outlined, seemed most pronounced in the epigastrium, and although no edge could be felt, consensus of opinion was that the mass represented enlarged liver. Radiographic examination of lungs showed no change, gall-bladder X-ray after ingestion of dye was negative, and gastro-intestinal X-ray series revealed a small ulcer of the lesser curvature of the pars media of the stomach.

The patient was kept under observation for three weeks, during which time her temperature remained at normal level and the upper abdominal mass gradually diminished in size until it could no longer be palpated. On January 25, 1927, she suffered an apparently typical attack of biliary colic without fever, leucocytosis or jaundice.

At operation, February 4, 1927, the gall-bladder, stomach and duodenum were found to be normal. Beneath the posterior wall of the stomach was a large, stony hard, nodular mass extending from the median line to the level of the cardia and in intimate relation with the hilus of the spleen. Extension of the process into the transverse mesocolon prevented the delivery of the transverse colon into the wound. There were no palpably enlarged retroperitoneal or mesenteric glands elsewhere within the abdomen and no gross evidence of tuberculous involvement of the peritoneum. The only accessible portion of the mass was near the median line and from this region a specimen was removed. During its removal, a small quantity of distinct pus was seen and part of the material obtained appeared to be caseous. Direct smear of the pus showed no organisms and a culture remained sterile. The operative wound was closed without drainage and healed by primary union.

Microscopical examination showed the specimen to consist of fat and areolar tissue containing masses of cells characterized by large polygonal cell bodies, slightly granular cytoplasm and small vesicular nuclei. Occasional giant cells containing two to three large nuclei and a number of cells resembling Langhan's giant cells but no suggestion of tubercle formation. In the masses of embryonal fat cells are interspersed fibroblasts, round cells and capillaries. Occasional eosinophilic leucocytes are seen. No mitotic figures or areas of necrosis. Diagnosis: Chronic productive inflammation in fibrofatty tissue.

OPERATION FOR CHARCOT'S DISEASE OF THE HIP-JOINT

This patient was presented because of the interest attached to her clinical course while under observation, and the isolated nature of the intra-abdominal tuberculous involvement

BRAIN TUMOR

DR JOSEPH P HOGUET presented a man, forty-six years of age, who entered the French Hospital, October 25, 1926, complaining of persistent occipital headaches, dizzy spells ringing in the ears and failing eyesight. His neurological examination showed a slight nystagmus, beginning choked discs in both eyes and a left homonymous hemianopsia. His knee-jerks were exaggerated and he had slight staggering to the left. Blood count and blood-pressure were normal. A spinal tap was done and the cerebro-spinal fluid found to be under considerable pressure. The cell count was normal and the spinal Wassermann negative.

November 4, 1926, a horseshoe-shaped incision was made on the right side of the skull posteriorly and an osteoplastic flap about 2 by 2 inches turned down. The dura was cut through and a tumor found adherent to its under surface and extending deeply into brain substance. As it seemed very difficult to remove the tumor and the patient's condition not being very good, the flap was loosely sutured back in position and the patient returned to bed. One week later the flap was turned down again. It was found necessary to enlarge the opening and this was done by cutting away more bone on one side with a rongeur. The tumor was then separated from the surrounding brain tissue by blunt dissection and removed. The cavity was packed with gauze as the hemorrhage was rather brisk, the flap turned back and the scalp wound partially sutured.

The patient made a good recovery but developed a partial motor and sensory paralysis of the right arm which cleared up shortly, leaving only a slight weakness in the limb.

After hardening in preserving fluid the tumor was found to be two and one-half by three inches in size and pronounced to be an endothelioma.

END RESULT IN RECONSTRUCTION OPERATION FOR CHARCOT'S DISEASE OF THE HIP-JOINT

DOCTOR HOGUET presented a man on whom he had operated December 28, 1923, for Charcot's disease of the hip. This patient contracted lues in 1913 for which he had been treated for several years. In the beginning of December, 1923, he developed pain in the right hip on walking and December 17, 1923, he sustained a pathological fracture of the neck of the femur a short distance from its junction with the head. At operation the fracture was found and there was also a large amount of sandy material, that could be scooped out with the fingers, filling the joint. The deformed head of the femur was found loose in the acetabulum, the ligamentum teres having disappeared. The loose head was removed. It was found to be oval, with a great deal of flattening on the upper surface which was rough and uncovered with cartilage.

A typical reconstruction operation according to the method of Royal Whitman was done, from which the patient made a very good recovery. He left the hospital in six weeks at which time he had an extremely good range of passive motion with one inch shortening in the limb. An X-ray taken at that time showed a great deal of new bone formation principally in the upper part of the new joint, apparently in the gluteal muscles, making a new roof for the joint. He discarded one crutch at the end of six months and the other at the end of a year, then using a cane as he had not regained

perfect confidence in the new joint. For a full year he was actively treated with anti-syphilitics, during all of which time the blood Wassermann was negative. A radiograph taken in October, 1926, showed some slight new formation of bone in the roof of the joint, but no extension of the disease into the shaft. When presented the patient had practically a normal range of motion in the joint.

DOCTOR HOGUET presented a young woman of twenty-six years, on whom he had operated in October, 1926, for a complete ankylosis of the hip-joint following a gonorrhœal arthritis. In this patient the typical reconstruction operation was done, the new head of the femur being covered with fascia lata. She now has practically complete passive motion in the joint but active extension has not returned as yet.

DR HOWARD LILIENTHAL called attention to one point made by Doctor Hoguet which he thought should be emphasized, and that was the remarkable shelf of bone which formed to make a new point of application for the femur, he wondered if this formation could always be expected in cases of this sort. Doctor Hoguet had apparently been surprised to find this bony outgrowth. The speaker had never seen anything like it before.

DR FENWICK BEEKMAN said that he had seen a case of dislocation of the hip with a fracture of the acetabulum where a new acetabulum was formed above the old, very much like that shown in the roentgenogram of Doctor Hoguet's case.

DOCTOR HOGUET, in closing the discussion, said that one reason he wanted to show these cases was that although he had seen a number he is still uncertain regarding the outcome. Doctor Whitman has a number of which he has done for osteoarthritis in which this roof of bone has not occurred. What the speaker wanted to bring out in the second case was the fact that, in spite of reaming out the new acetabulum and covering the new head of the femur with fascia lata in this case, the new head of the femur jumped out of what was intended to be the new acetabulum and formed another acetabulum with this roof of bone.

BRACHIAL PLEXUS PRESSURE BY THE NORMAL FIRST RIB

DR WALTER M. BRICKNER read a paper with the above title, for which see page 858.

DR HOWARD LILIENTHAL said that if there is indeed a normal first rib, it is more than probable the vessels and nerves are at fault and that they have been dragged over outer edge of the rib. As to the division of the rib and the technic. First of all, as to the presence of a condition of this type there is little doubt, not only because of the relief following the operation, but because of the relief of symptoms afforded by the use of a sling and raising of the shoulder by the patient. Whether the nerves or artery are most to blame for the symptoms the speaker was not so sure. He had an idea it was pressure of the subclavian artery on the rib which is quite as apt to cause pain as the nerve, the nervi vasorum being sensory. The distribution of the brachial plexus is so varied that one could probably not make a diagnosis as to whether it was nerve or vessel which caused the pain. As to the relief,

if there is pressure on the vessel over the edge of the first rib, removal of that edge should produce relief. Handling the brachial plexus even very lightly and carefully will often cause neuritis, sometimes lasting several months, although it usually disappears after six weeks.

DOCTOR LILIENFELD said he had noticed that when the first rib is divided from behind, as a paravertebral thoracoplasty, the rib will drop an astonishing distance, even to the second or third intercostal space posteriorly, and does not go back again. So it makes little difference if one takes periosteum or not. Doctor Brickner's incision, which is original with him, is by far preferable to any known to the speaker. The scar was very beautiful and, even in this short time, not obtrusive.

DR JOHN J MOORHEAD said that Doctor Brickner had given another cause for painful shoulders. The speaker had not had any experience with such cases as had been described in the paper of the evening, but he wished to show X-rays of a case of bilateral supernumerary cervical ribs which had right-sided symptoms for four months, but the condition had been first recognized four years ago. The post-operative X-rays show the removal of one inch of rib on the right side in March, 1926. The relief from neural and vascular symptoms up to the present time had been perfectly satisfactory. The operation was done by an incision posterior to the external border of the mastoid and the rib was removed by a Gigli saw.

DR BYRON STOOKEY said that the differential diagnosis of pain in the arm caused by cervical rib syndrome or pressure by a normal first rib or so-called brachial neuritis is fraught with considerable difficulty. In many the symptoms are entirely subjective without definite objective signs. Pain and weakness of the arm may be due to a variety of dissimilar conditions. Persistent unradicular pain may be due to intrinsic spinal cord disease, to discreet circumscribed spinal cord tumors such as a chondroma beneath a nerve root or a neurofibroma arising from a nerve root. These patients may complain of pain in the arm for several years. They are often treated for so-called brachial neuritis until further evolution of the disease indicates its spinal cord origin.

Another common source of pain in the arm which Dr. Louis Casamajor and the speaker have recognized for a number of years in the Vanderbilt Clinic is a myositis of one or more of the shoulder girdle muscles with pain radiating down the outer or inner aspect of the arm, indefinite and vague sensory changes, and some weakness of the extremity. Eight of these patients were waiting for a neuro-surgical consultation at the Vanderbilt Clinic several years ago, having been diagnosed by competent neurologists as brachial neuritis, so similar is their symptomatology. All proved to be myositis of one or more of the shoulder girdle muscles and all were relieved of their symptoms by appropriate massage and physiotherapeutic measures.

The diagnosis is made by having the patient in such position as to relax the shoulder girdle muscles. This is best accomplished by having the patient prone with the forearm and hands over the edge of the table. A search is

then made for tender nodules in the muscles of the shoulder girdle. These are best felt with the thumb and are usually found in the teres major, infraspinous, supraspinatus and trapezius muscles. The nodule is discreet and exquisitely tender to deep pressure. When such a nodule is found the patient resents vividly any deep pressure upon it.

Massage directed to the areas of induration in the muscle will usually clear up all the symptoms within four to six weeks. The diagnosis of myositis of the shoulder girdle muscles is not as frequently made as it should be. The speaker was in entire agreement with Oppenheim's (1908) view that brachial neuralgia is a rare affection.

The production of pressure symptoms by a normal first thoracic rib is an extremely interesting problem. The speaker agreed with Doctor Lilienthal in the belief that the abnormality is not in the rib but in the soft tissues—namely, the brachial plexus.

By transplantation of limb buds it has been shown that the position of the limb bud determines in a measure the component segmental innervation of the limb bud. For example, if the limb bud has a more cephalic position its innervation is more cephalic and vice versa. Thus a normal limb bud arising a segment or two more cephalic would determine a more cephalic cervical nerve contribution to it while a limb bud arising a segment or two more caudal would determine a more caudal cervical innervation—thus, for example, in the former limb bud the brachial plexus would be made up of a large contribution from the fourth cervical root while in the latter form the fourth cervical would contribute no fibres but instead a larger contribution would be derived from the first thoracic or second thoracic nerve. Thus the more caudal cervical nerves come to innervate the limb bud having the more caudal position. It is in this type of plexus that symptoms of rib pressure by a normal first thoracic rib on the plexus is likely to occur. The limb bud and nerves to the limb bud have shifted caudalward while the thoracic skeletal structures have retained their normal position. Consequently, when indisputable signs of pressure on the lower roots of the brachial plexus are evident removal of the first thoracic rib is indicated. The reader of the paper has called attention to an important mode of treatment other than surgical measures which may be useful in those cases in which the pressure exerted is relatively slight. It is in any case a measure well worth trying before attempting any surgical procedure and especially until the diagnosis is well established and the differential diagnosis made.

DOCTOR BRICKNER, in closing the discussion, said in reply to Doctor Lilienthal, that although he had demonstrated and reported a case in which there was evidence of pressure on the subclavian artery this is unusual, for even when there are vascular symptoms these are usually vasomotor, due rather to plexus than to blood-vessel pressure, i. e. to pressure chiefly upon the lower cord as it passes over the *inner* edge of the first rib.

He did not touch upon the mechanics of the condition for, as he stated in his paper, he had dealt with a consideration of these in his

earlier publication and had then discussed the embryologic and developmental factors referred to by Doctor Stookey. While one of the photographs of Doctor Buckner's case taken six days after the operation *did* appear to show a little drooping of the eyelid on the opposite (unaffected) side, he could assure Doctor Stookey that this patient had no ptosis, enophthalmos or Horner's syndrome on either side, also that she had no rudimentary (cervical) rib or abnormality long seventh cervical transverse processes. Moreover a long transverse process is not a rudimentary rib. He regretted that Doctor Stookey had understood him to say that there was any drooping of the rib in these cases. The ribs are normal in position as well as in shape. When there is any droop it is of the shoulder, dragging the plexus over an entirely normal rib. No doubt there are cases of myositis causing pain resembling that of brachial neuritis, but surely such cases as he had reported, with torturing pain over periods of many years, with vasomotor symptoms and, some of them, with typical lower cord irritation symptoms, could not be confused with myositis.

BRIEF COMMUNICATIONS

THE IMMEDIATE APPEARANCE OF A FRACTURE OF THE LOWER EXTREMITY OF THE RADIUS

THERE recently came into our charge the body of J E, a colored man of thirty-four years (No 1447), who had died of "alcoholism" A friend hit him on the jaw and fractured the mandible through the socket of the right

second bicuspid tooth The injured man fell over to the left and reaching out with the hand to break his fall, sustained a fracture of the left wrist Dying almost immediately, he was removed to the County Morgue and thence to the laboratory, thus giving us the opportunity to study the features of a newly made fracture of the lower extremity of the radius without impaction

Figure 1 shows the fragments as they appeared after maceration when restored to their relative position There is typical displacement of lower fragment backwards and outwards with rotation in the same directions

Figure 2 shows the fragments in normal relationship to each other as

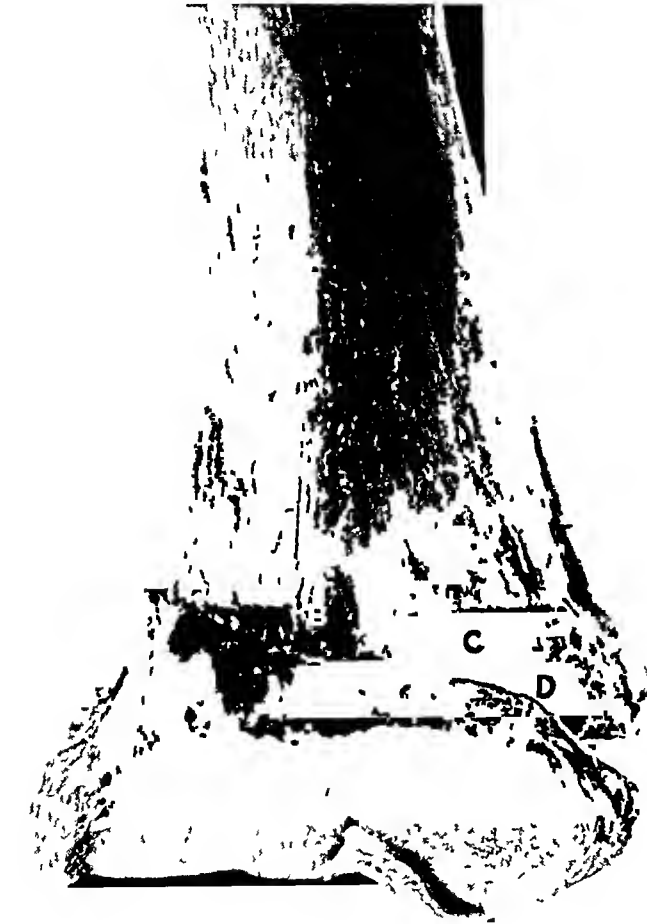


FIG 1 —Fracture of the lower extremity of the left radius No 1447 male negro thirty four Fragments in displacement seen from behind Typical displacement and rotation, no impaction A B D Projections on lower fragment with crushed cancellous tissue C Depression with crushed cancellous tissue These conditions are apparent also in Figs 2 and 3

the parts were before fracture There is a short fissured fracture running up the shaft from the region of the dorsal radial tubercle and a large area of thin compact tissue of the dorsal aspect of the bone is thoroughly splintered and lost in maceration

The fractured faces, being perfectly fresh, never impacted, and having been macerated with the utmost care, are most instructive (Fig 3)

In the fractured face of lower fragment are three depressions subdivided

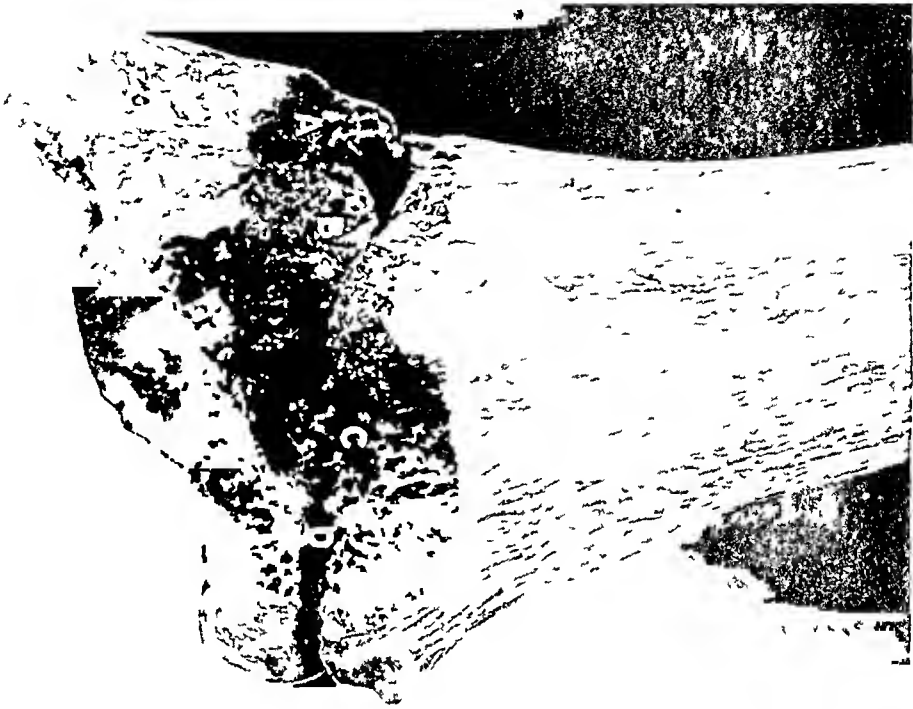


Fig. 2.—Fragments restored to natural position to show the amount of tissue actually lost

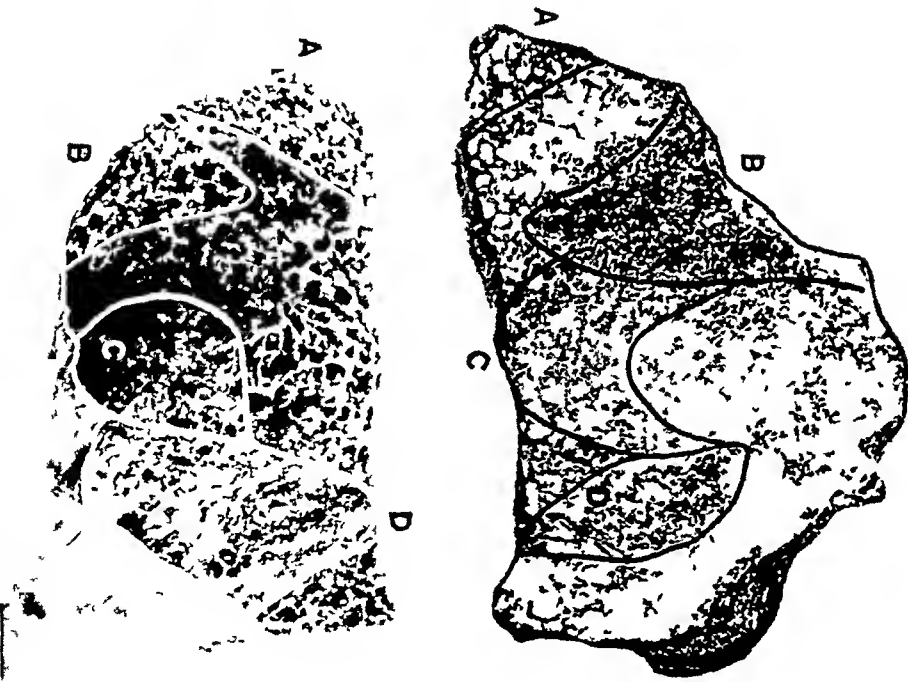


Fig. 3.—Fractured faces of fragments. Lower fragment above, upper below. Note the crushed cancellous tissue the several corresponding areas of which have been lettered to indicate the contacts at the moment of impact

BRIEF COMMUNICATIONS

from each other by two intervening rounded elevations. Correspondingly the upper fragment has three elevations separated by two roughly antero-posterior grooves. Although impaction did not take place in this bone, it is easy to see just how and where impaction usually occurs for the areas of upper and lower fragments which have been driven violently against each other are readily identified by their crushed cancellous tissue. Upon the basis of the damage to the cancellous tissue we have picked out by white encircling lines the corresponding areas on the two fracture faces. Areas which have been in contact with each other at the moment of impact are indicated by the same letter.

The sigmoid outline of the fracture through the lower extremity of the radius follows pretty definitely the plane apparent in bones of which the lower end has crumbled after maceration and hence is seemingly determined by the texture of the cancellous tissue rather than by the violence of the glancing blow. If impaction occurs, it takes place at the areas to which attention has been drawn.

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INFECTIONS OF THE FACE

IN THE issue of the ANNALS OF SURGERY, March 1927, there is an article on Infection of the Face, with reports of interesting cases of carbuncle of the face, by Dr. John Price. He was kind enough to refer to a paper of my own on the same subject.

I take this opportunity to correct a wrong impression. I did not wish to give the impression that incision into circumscribed foci in the lip or nostril would lead to disaster. I have seen a number of these infections incised and have incised several myself with no untoward outcome. Two of the patients reported in the paper, one by Reverdin and one by Powers, recovered following incisions. Nor do I wish to imply that recovery will follow if they are protected from injury but not incised. I thought, when I wrote the paper and still think, that repeated incisions and repeated trauma, especially in the early stage and in the later stage when the *focus of infection* is not easily made out, are factors determining the spread of infection.

I know from experience that many heal without any intervention, even when there is brawny swelling and widespread œdema.

In such cases as those reported it would be interesting if we could have controls with and without incision and drainage. I imagine that opening the focus at a certain stage relieves pain, I do not believe it shortens the course of the infection or influences favorably the outcome.

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TRACTION IN REDUCTION OF A SUPRACONDYLAR "T" FRACTURE

TRACTION IN THE REDUCTION OF A SUPRACONDYLAR "T" FRACTURE OF THE HUMERUS

INCREASING use is being made of skeletal traction in the treatment of fractures of the long bones. There is, however, little to be found in the



FIG 1 —Showing extent of primary injury

literature advocating this method in the care of fractures of the lower end of the humerus

J C, a man of forty, was admitted to the First Surgical Division, Bellevue Hospital, July 28, 1925. X-ray showed a supracondylar "T" fracture of the humerus with over-



FIG 2 —Showing position of fragments forty-eight hours after application of calipers

riding, and extreme separation of the two lower fragments (Fig 1). A satisfactory reduction required traction in the long axis of the humerus, together with lateral pressure on the lower fragments. It seemed that these requirements could be most readily met by the use of tongs. Under ether anesthesia and with a tourniquet applied to the upper

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arm, and incision was made over each supracondylar ridge. The periosteum was divided and a small hole bored with a bit and brace just proximal to each condyle. Into these holes the caliper points were placed and tension maintained by passing a rubber tube about the arms of the tongs. The patient was returned to bed and the arm put up in right angle traction. Gentle active motion was begun as soon as the effects of the anæsthetic had fully worn off. Figure 2 shows the position of the fragments after forty-



FIG 3—X-ray taken six months after injury

eight hours of traction. After six days the calipers were removed as they were commencing to cause considerable discomfort, and the arm placed in moderately acute flexion in a posterior moulded splint. Figure 3 shows the elbow six months later at which time there was full pronation and supination with twenty degrees of flexion from the right angle and eighty degrees of extension. The patient, a bricklayer, has since resumed his occupation.

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